

KWV EDUCATION



KWV PHYSICS GRADE 12

CHEMICAL CHANGE SOLUTIONS

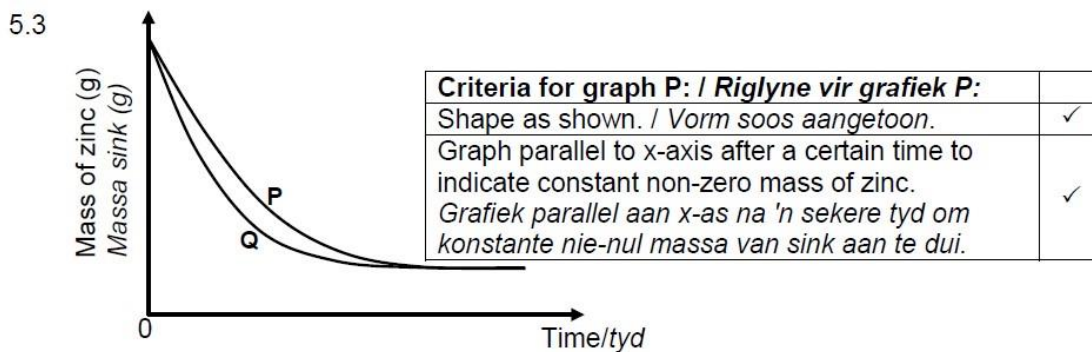
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WHERE TO START IN MATHS AND SCIENCE

QUESTION 5/VRAAG 5

5.1 Hydrochloric acid / HCl / Soutsuur ✓ (1)

5.2 Hydrogen gas escapes from the flask. ✓
Waterstofgas ontsnap uit die fles. (1)



(2)

5.4

Criteria for graph Q / Riglyne vir grafiek Q:	
Steeper gradient than Graph P. / Steiler gradiënt as Grafiek P.	✓
Joins parallel section of Graph P after a shorter time.	
Verbind met die parallelle deel van Grafiek P na 'n korter tyd.	

(1)

5.5 At a higher temperature:

- More molecules have sufficient kinetic energy / kinetic energy equal to or greater than the activation energy. ✓
- More effective collisions per unit time / second. ✓

By 'n hoër temperatuur:

- Meer molekule het voldoende kinetiese energie / kinetiese energie gelyk aan of groter as die aktiveringsenergie.
- Meer effektiewe botsings per eenheidstyd / sekond. ✓

(2)

5.6

$$c(\text{HCl}) = \frac{n}{V} \quad \checkmark$$

$$\therefore 0,2 = \frac{n}{0,1} \quad \checkmark$$

$$\therefore n(\text{HCl}) = 0,02 \text{ mol}$$

$$n(\text{Zn}) = \frac{1}{2}n(\text{HCl}) = 0,01 \text{ mol} \quad \checkmark$$

$$m(\text{Zn reacted / gereageer}) = nM \quad \checkmark$$

$$= (0,01)(65) \quad \checkmark$$

$$= 0,65 \text{ g}$$

Mass of Zn initially in flask / Massa Zn aanvanklik in fles:

$$0,65 + 0,12 = 0,77 \text{ g} \quad \checkmark$$

(6)
[13]

QUESTION 6/VRAAG 6

- 6.1 The stage in a chemical reaction when the rate of forward reaction equals the rate of reverse reaction. ✓✓
Die stadium in 'n chemiese reaksie wanneer die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. ✓✓ (2)
- 6.2
 6.2.1 Higher than / Hoër as ✓ (1)
 6.2.2 Equal to / Gelyk aan ✓ (1)
- 6.3
 6.3.1 NO₂(g) added / bygevoeg ✓ (1)
 6.3.2 Decrease in pressure / Afname in druk ✓ (1)
- 6.4 Increases ✓
 An increase in temperature favours the endothermic reaction. ✓
 The forward reaction is endothermic. / The forward reaction is favoured. ✓
Verhoog
'n Toename in temperatuur bevoordeel die endotermiese reaksie.
Die voorwaartse reaksie is endotermies. / Die voorwaartse reaksie word bevoordeel. (3)

6.5

	N ₂ O ₄	NO ₂	
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	0,92	0	
Change (mol) <i>Verandering (mol)</i>	0,19 ✓	0,38	ratio ✓ verhouding
Quantity at equilibrium (mol)/ <i>Hoeveelheid by ewewig (mol)</i>	0,73	0,38 ✓	
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	$\frac{0,73}{2} = 0,37$	$\frac{0,38}{2} = 0,19$	

$$K_c = \frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]} \checkmark$$

$$= \frac{(0,19)^2}{(0,37)} \checkmark$$

$$= 9,76 \times 10^{-2} \checkmark$$

Divide by / gedeel deur 2 ✓

No K_c expression, correct substitution /
 Geen K_c-uitdrukking, korrekte substitusie:
 Max. / Maks. 6/7

Wrong K_c expression / Verkeerde K_c-
 uitdrukking: Max. / Maks. 4/7

(7)
 [16]

QUESTION 5 / VRAAG 5

5.1 **ONLY ANY ONE OF/ SLEGS ENIGE EEN VAN:**

- Change in concentration of products / reactants ✓ per (unit) time. ✓
Verandering in konsentrasie van produkte / reaktanse per (eenheids)tyd.
- Rate of change in concentration. ✓✓
Tempo van verandering in konsentrasie.
- Change in amount / number of moles / volume / mass of products or reactants per (unit) time.
Verandering in hoeveelheid / getal mol/volume / massa van produkte of reaktanse per (eenheids)tyd.
- Amount / number of moles / volume / mass of products formed or reactants used per (unit) time.
Hoeveelheid / getal mol / volume / massa van produkte gevorm of reaktanse gebruik per (eenheids)tyd.

(2)

5.2

5.2.1 Temperature / *Temperatuur* ✓

(1)

5.2.2 Rate of reaction / Volume of gas (formed) per (unit) time ✓

Reaksietempo / Volume gas (gevorm) per (eenheids)tyd

(1)

5.3

- Larger mass / amount / surface area. ✓
Groter massa / hoeveelheid / reaksieoppervlak.
- More effective collisions per (unit) time. / Frequency of effective collisions increase. / More particles collide with sufficient kinetic energy & correct orientation per (unit) time. ✓✓
Meer effektiewe botsings per (eenheids)tyd. / Frekwensie van effektiewe botsings verhoog. / Meer deeltjies bots met genoeg kinetiese energie & korrekte oriëntasie per tyd(seenheid).

IF / INDIEN:

- Larger mass / amount / surface area. ✓
Groter massa / hoeveelheid / reaksieoppervlak.
- More particles collide. / More collisions. ✓
Meer deeltjies bots. / Meer botsings.

Max./Maks. $\frac{2}{3}$

Notes / Aantekeninge:

IF/INDIEN:

No reference to mass / amount / surface area in answer:

Geen verwysing na massa / hoeveelheid / reaksieoppervlak in antwoord:

$\frac{0}{3}$

(3)

Compare Exp. 1 with Exp. 2: Vergelyk Eksp. 1 met Eksp. 2:	The reaction in <u>exp. 1</u> is <u>faster</u> in exp. 1 than in <u>exp. 2</u> due to the <u>higher acid concentration</u> . <i>Die reaksie in eksp. 1 is vinniger as dié in eksp. 2 as gevolg van die hoër suurkonsentrasie.</i>	✓
	Therefore the <u>gradient</u> of the graph representing <u>exp. 1</u> is <u>greater / steeper</u> than that of <u>exp. 2</u> . / Graph of Exp. 1 reaches constant volume in shorter time than exp. 2. <i>Dus is die gradiënt van die grafiek wat eksp. 1 voorstel, groter/steiler as dié vir eksp. 2. / Grafiek van exp. 1 bereik konstante volume in korter tyd as dié vir eksp. 2.</i>	✓
Compare Exp. 1 with Exp 3 & 4: Vergelyk Eksp. 1 met Eksp. 3 & 4:	The reaction in <u>exp. 3</u> is <u>faster</u> than that in <u>exp. 1</u> due to the <u>higher temperature</u> . <i>Die reaksie in eks. 3 is vinniger as dié in eksp. 1 as gevolg van die hoër temperatuur.</i>	✓
	The reaction in <u>exp. 4</u> is <u>faster</u> than that in <u>exp. 1</u> due to the <u>higher temperature / larger surface area</u> . <i>Die reaksie in eks. 4 is vinniger as dié in eksp. 1 as gevolg van die hoër temperatuur / groter reaksieoppervlak.</i> OR/OF Graph <u>A</u> represents <u>exp. 4</u> due to the <u>greater mass</u> of CaCO_3 - greater yield of CO_2 at a faster rate. <i>Grafiek A stel eksp. 4 voor as gevolg van die groter massa CaCO_3 - groter opbrengs CO_2 teen vinniger tempo.</i>	✓
	Therefore the <u>gradient</u> of the graphs of <u>exp. 3 & 4</u> are <u>greater/steeper</u> than that of <u>exp. 1</u> . / Graphs of Exp. 3 & 4 reaches constant volume in shorter time than exp. 1. <i>Dus is die gradiënte van die grafieke vir eksp. 3 & 4 is groter/steiler as dié in eksp. 1. / Grafieke van exp. 3 & 4 bereik konstante volume in korter tyd as dié vir eksp. 1.</i>	✓
Final answer Finale antwoord	C	✓

(6)

Notes/Aantekeninge

- Compare exp. 1 with exp. 2 / Vergelyk eksp. 1 met eksp. 2:
 - Factor & rate / Faktor & tempo.
 - Gradient / volume CO_2 per time / gradient / volume CO_2 per tyd.
- Compare exp. 1 with exp. 3 / Vergelyk eksp. 1 met eksp. 3:
 - Factor & rate / Faktor & tempo.
- Compare exp. 1 with exp. 4 / Vergelyk eksp. 1 met eksp. 4:
 - Factor & rate / Faktor & tempo.
- Compare gradient / volume CO_2 per time of exp 1 with that of exp. 3 & 4
Vergelyk gradient/volume CO_2 per tyd van eksp 1 met die van eksp. 3 & 4
- Final answer / finale antwoord: C

Marking criteria / Nasienriglyne:

- Divide volume by / Deel volume deur: 25,7 ✓
- Use ratio / Gebruik verhouding: $n(\text{CO}_2) = n(\text{CaCO}_3) = 1:1$ ✓
- Substitute / Vervang 100 in $n = \frac{m}{M}$. ✓
- Subtraction / Aftrekking. ✓
- Final answer / Finale antwoord: 7,00 g to/tot 7,5 g ✓

OPTION 1 / OPSIE 1

$$n(\text{CO}_2) = \frac{V}{V_m}$$

$$= \frac{4,5}{25,7} \checkmark$$

$$= 0,18 \text{ mol } (0,175 \text{ mol})$$

$$n(\text{CaCO}_3) = n(\text{CO}_2) = 0,18 \text{ mol } \checkmark$$

$$n(\text{CaCO}_3) = \frac{m}{M}$$

$$0,18 = \frac{m}{100} \checkmark$$

$$\therefore m = 18 \text{ g } (17,5 \text{ g})$$

$$m(\text{CaCO}_3 \text{ not reacted/nie gereageer nie}):$$

$$25 - 18 \checkmark = 7,00 \text{ g } \checkmark \quad (7,49 \text{ g})$$

(Accept range: 7,00 g – 7,5 g)
(Aanvaar gebied: 7,00 g – 7,5 g)

OPTION 3 / OPSIE 3

$$25,7 \text{ dm}^3 : 1 \text{ mol}$$

$$4,5 \text{ dm}^3 : 0,18 \text{ mol } \checkmark$$

$$100 \text{ g } \checkmark : 1 \text{ mol}$$

$$x : 0,18 \text{ mol } \checkmark$$

$$x = 18 \text{ g}$$

$$m(\text{CaCO}_3 \text{ not reacted/nie gereageer nie}):$$

$$25 - 18 \checkmark = 7,00 \text{ g } \checkmark$$

(Accept range: 7,00 g – 7,5 g)
(Aanvaar gebied: 7,00 g – 7,5 g)

OPTION 2 / OPSIE 2

Calculate mass of CO_2 :
Bereken massa CO_2 :

$$n(\text{CO}_2) = \frac{V}{V_m}$$

$$= \frac{4,5}{25,7} \checkmark$$

$$= 0,18 \text{ mol } (0,175 \text{ mol})$$

$$n(\text{CO}_2) = \frac{m}{M}$$

$$0,18 = \frac{m}{44}$$

$$\therefore m(\text{CO}_2) = 7,92 \text{ g } (7,7043 \text{ g})$$

Ratio/
verhouding

$$m(\text{CaCO}_3 \text{ needed / benodig}) = \frac{7,92}{44} \times 100 \checkmark$$

$$= 18 \text{ g } (17,5 \text{ g})$$

$$m(\text{CaCO}_3 \text{ not reacted/nie gereageer nie}):$$

$$25 - 18,00 \checkmark = 7,00 \text{ g } \checkmark \quad (7,49 \text{ g})$$

(Accept range: 7,00 g – 7,5 g)
(Aanvaar gebied: 7,00 g – 7,5 g)

(5)

OPTION 4 / OPSIE 4

$$100 \text{ g CaCO}_3 \rightarrow 25,7 \text{ dm}^3 \text{ CO}_2 \checkmark \checkmark$$

$$x \text{ g} \rightarrow 4,5 \text{ dm}^3 \text{ CO}_2 \checkmark$$

$$\therefore x = 17,51 \text{ g}$$

$$\text{Mass not reacted/Massa nie gereageer nie}$$

$$= 25 - 17,51 \checkmark$$

$$= 7,49 \text{ g } \checkmark$$

(Accept range: 7,00 g – 7,5 g)
(Aanvaar gebied: 7,00 g – 7,5 g)

(5)

QUESTION 6 / VRAAG 6

- 6.1 The stage in a chemical reaction when the rate of forward reaction equals the rate of reverse reaction. ✓✓
Die stadium in 'n chemiese reaksie wanneer die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. ✓✓

OR / OF

The stage in a chemical reaction when the concentrations of reactants and products remain constant. ✓✓
Die stadium in 'n chemiese reaksie wanneer die konsentrasies van reaktanse en produkte konstant bly. ✓✓

(2)

6.2

CALCULATIONS USING NUMBER OF MOLES **BEREKENINGE WAT GETAL MOL GEBRUIK**

Mark allocation / Puntetoekenning:

- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c uitdrukking (formules in vierkanthakies).
- Substitution of concentrations into K_c expression. ✓
Vervanging van konsentrasies in K_c -uitdrukking.
- Substitution of K_c value / Vervanging van K_c -waarde. ✓
- Equilibrium concentration of both NO_2 & N_2O_4 multiplied by $0,08 \text{ dm}^3$. ✓
Ewewigskonsentrasie van beide NO_2 & N_2O_4 vermenigvuldig met $0,08 \text{ dm}^3$
- Change in $n(\text{N}_2\text{O}_4)$ = equilibrium $n(\text{N}_2\text{O}_4)$ – initial $n(\text{N}_2\text{O}_4)$ ✓
Verandering in $n(\text{N}_2\text{O}_4)$ = ewewig $n(\text{N}_2\text{O}_4)$ – aanvanklike $n(\text{N}_2\text{O}_4)$
- **USING** ratio / **GEBRUIK** verhouding: $\text{NO}_2 : \text{N}_2\text{O}_4 = 2 : 1$ ✓
- Initial $n(\text{NO}_2)$ = equilibrium $n(\text{NO}_2)$ + change $n(\text{NO}_2)$. ✓
Aanvanklike $n(\text{NO}_2)$ = ewewig $n(\text{NO}_2)$ + verandering $n(\text{NO}_2)$.
- Final answer / Finale antwoord: 1,11 (mol) ✓
Accept range/Aanvaar gebied: 1,11 – 1,12 (mol)

OPTION 1 / OPSIE 1

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \checkmark$$

$$171 \checkmark = \frac{[N_2O_4]}{(0,2)^2} \checkmark$$

$$\therefore [N_2O_4] = 171 \times (0,2)^2 = 6,84 \text{ mol}\cdot\text{dm}^{-3}$$

No K_c expression, correct substitution / *Geen K_c -uitdrukking, korrekte substitusie*: Max./Maks. $\frac{7}{8}$

Wrong K_c expression / *Verkeerde K_c -uitdrukking*: Max./Maks. $\frac{5}{8}$

(8)

	NO ₂	N ₂ O ₄	
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	1,11 ✓	0	
Change (mol) <i>Verandering (mol)</i>	1,094	0,55 ✓	ratio ✓ <i>verhouding</i>
Quantity at equilibrium (mol)/ <i>Hoeveelheid by ewewig (mol)</i>	0,016	0,55	
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	0,2	6,84	x 0,08 ✓

OPTION 2 / OPSIE 2

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \checkmark$$

$$171 \checkmark = \frac{[N_2O_4]}{(0,2)^2} \checkmark$$

$$\therefore [N_2O_4] = 171 \times (0,2)^2 = 6,84 \text{ mol}\cdot\text{dm}^{-3}$$

No K_c expression, correct substitution / *Geen K_c -uitdrukking, korrekte substitusie*: Max./Maks. $\frac{7}{8}$

Wrong K_c expression / *Verkeerde K_c -uitdrukking*: Max./Maks. $\frac{5}{8}$

Equilibrium moles / Ewewigsmol:

$$\left. \begin{aligned} n(N_2O_4) &= (6,84)(0,080) \\ &= 0,55 \text{ mol} \\ n(NO_2) &= (0,2)(0,080) \\ &= 0,016 \text{ mol} \end{aligned} \right\} \checkmark \times 0,08 \text{ dm}^3$$

$$n(N_2O_4 \text{ formed/gevorm}) = 0,55 - 0 = 0,55 \text{ mol} \checkmark$$

Ratio / *Verhouding*:

$$n(NO_2 \text{ reacted / gereageer}) = 2n(N_2O_4 \text{ formed/gevorm}) = 2(0,55) = 1,094 \text{ mol}$$

$$\checkmark \text{ Initial / Aanvanklike } n(NO_2) = 0,016 + 1,094 \checkmark = 1,11 \text{ (mol)} \checkmark$$

(8)

OPTION 3 / OPSIE 3

	NO ₂	N ₂ O ₄	
Initial quantity (mol) Aanvangshoeveelheid (mol)	2x + 0,016	0	
Change (mol) Verandering (mol)	2x	x ✓	ratio ✓ verhouding
Quantity at equilibrium (mol)/ Hoeveelheid by ewewig (mol)	0,016	x	
Equilibrium concentration (mol·dm ⁻³) Ewewigskonsentrasie (mol·dm ⁻³)	0,2	$\frac{x}{0,08}$	x 0,08 & ÷ 0,08 ✓

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \checkmark$$

$$171 \checkmark = \frac{x}{(0,2)^2} \checkmark$$

$$\therefore x = 0,5472$$

$$\therefore n(\text{initial/aanvanklik}) = 2(0,5472) + 0,016 = 1,11 \text{ mol} \checkmark$$

No K_c expression, correct substitution/Geen K_c-uitdrukking, korrekte substitusie: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/Verkeerde K_c-uitdrukking: Max./Maks. $\frac{5}{8}$

(8)

OPTION 4 / OPSIE 4

	NO ₂	N ₂ O ₄	
Initial quantity (mol) Aanvangshoeveelheid (mol)	x	0	
Change (mol) Verandering (mol)	x - 0,016	$\frac{x - 0,016}{2} \checkmark$	ratio ✓ verhouding
Quantity at equilibrium (mol)/ Hoeveelheid by ewewig (mol)	0,016	$\frac{x - 0,016}{2}$	
Equilibrium concentration (mol·dm ⁻³) Ewewigskonsentrasie (mol·dm ⁻³)	0,2	$\frac{x - 0,016}{0,16}$	x 0,08 & ÷ 0,08 ✓

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \checkmark$$

$$171 \checkmark = \frac{\frac{x - 0,016}{2}}{(0,2)^2} \checkmark$$

$$\therefore x = 1,11 \text{ mol} \checkmark$$

No K_c expression, correct substitution/Geen K_c-uitdrukking, korrekte substitusie: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/Verkeerde K_c-uitdrukking: Max./Maks. $\frac{5}{8}$

(8)

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Mark allocation / Punttoekenning:

- Correct K_c expression (formulae in square brackets). ✓
 Korrekte K_c uitdrukking (formules in vierkanthakies).
- Substitution of concentrations into K_c expression. ✓
 Vervanging van konsentrasies in K_c -uitdrukking.
- Substitution of K_c value. / Vervanging van K_c -waarde. ✓
- Change in $[N_2O_4]$ = equilibrium $[N_2O_4]$ – initial $[N_2O_4]$. ✓
 Verandering in $[N_2O_4]$ = ewewig $[N_2O_4]$ – aanvanklike $[N_2O_4]$.
- **USING** ratio/**GEBRUIK** verhouding: $NO_2 : N_2O_4 = 2 : 1$ ✓
- Initial $[NO_2]$ = equilibrium $[NO_2]$ + change in $[NO_2]$. ✓
 Aanvanklike $[NO_2]$ = ewewigs $[NO_2]$ + verandering in $[NO_2]$.
- Equilibrium concentration of $[NO_2]$ multiplied by 0,08 dm³. ✓
 Ewewigskonsentrasie van $[NO_2]$ vermenigvuldig met 0,08 dm³.
- Final answer/Finale antwoord: 1,11 (mol) ✓
 Accept range/Aanvaar gebied: 1,11 – 1,12 (mol)

OPTION 5 / OPSIE 5

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \quad \checkmark$$

$$171 \checkmark = \frac{[N_2O_4]}{(0,2)^2} \quad \checkmark$$

$$\therefore [N_2O_4] = 171 \times (0,2)^2 \\ = 6,84 \text{ mol} \cdot \text{dm}^{-3}$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/Verkeerde K_c -uitdrukking:
 Max./Maks. $\frac{5}{8}$

	NO_2	N_2O_4	
Initial concentration (mol·dm ⁻³) Aanvangskonsentrasie (mol·dm ⁻³)	13,88	0	
Change (mol·dm ⁻³) Verandering (mol·dm ⁻³)	13,68	6,84 ✓	ratio ✓ verhouding
Equilibrium concentration (mol·dm ⁻³) Ewewigskonsentrasie (mol·dm ⁻³)	0,2	6,84	

$$n(NO_2) = cV = (13,88)(0,08) \checkmark = 1,11 \text{ mol} \checkmark$$

(8)

OPTION 6 / OPSIE 6

	NO ₂	N ₂ O ₄	
Initial concentration (mol·dm ⁻³) <i>Aanvangskonsentrasie (mol·dm⁻³)</i>	x	0	
Change (mol·dm ⁻³) <i>Verandering (mol·dm⁻³)</i>	x - 0,2	$\frac{x - 0,2}{2}$ ✓	ratio ✓ <i>verhouding</i>
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	0,2	$\frac{x - 0,2}{2}$	

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} \checkmark$$

$$171 \checkmark = \frac{\frac{x - 0,2}{2}}{(0,2)^2} \checkmark$$

$$\therefore x = 13,88 \text{ mol·dm}^{-3}$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./Maks. $\frac{5}{8}$

$$n(NO_2) = cV = (13,88)(0,08) \checkmark = 1,11 \text{ mol} \checkmark \quad (8)$$

6.3

6.3.1 Concentration (of the gases) increases. / Molecules become more condensed or move closer to each other. ✓
Konsentrasie (van die gasse) verhoog. / Molekule word meer saamgepers of beweeg nader aan mekaar. (1)

- 6.3.2
- Increase in pressure favours the reaction that leads to smaller number of moles / volume of gas. ✓
Toename in druk bevoordeel die reaksie wat tot die kleiner getal mol / volume gas lei.
 - Forward reaction is favoured. / *Voorwaartse reaksie word bevoordeel.* ✓
 - Number of moles/amount of N₂O₄ / colourless gas increases. ✓
Aantal mol/hoeveelheid N₂O₄ / kleurlose gas neem toe.

OR / OF

Number of moles/amount of NO₂ / brown gas decreases. ✓
Aantal mol/hoeveelheid NO₂ / bruin gas neem af. (3)

6.4

6.4.1 Darker / *Donkerder* ✓ (1)

6.4.2 Decreases / *Verlaag* ✓ (1)

[16]

QUESTION 5/VRAAG 5

- 5.1 Exothermic/Eksotermies ✓
Temperature increases during reaction./ $T_i < T_f$ ✓
Temperatuur verhoog tydens die reaksie./ $T_i < T_f$ (2)
- 5.2 Larger surface area in experiment 2. ✓
Groter reaksieoppervlakte in eksperiment 2.
OR/OF
Smaller surface area in experiment 1. ✓
Kleiner reaksieoppervlakte in eksperiment 1. (1)
- 5.3 More than one independent variable. ✓
Meer as een onafhanklike veranderlike.
OR/OF
Different concentrations and state of division. ✓
Verskillende konsentrasies en toestand van verdeeldheid. (1)
- 5.4 Faster than ✓
Vinniger as
A catalyst was used in experiment 5. ✓
'n Katalisator is gebruik in eksperiment 5.
• A catalyst provides an alternative pathway of lower activation energy. ✓
'n Katalisator voorsien 'n alternatiewe pad van laer aktiveringsenergie.
• More molecules have sufficient/enough kinetic energy.
Meer molekule het voldoende/genoeg kinetiese energie. ✓
OR/OF
More molecules have kinetic energy equal to or greater than the activation energy.
Meer molekule het kinetiese energie gelyk aan of groter as die aktiveringsenergie.
• More effective collisions per unit time./Rate or frequency of effective collisions increases. ✓
Meer effektiewe botsings per eenheidstyd./Tempo of frekwensie van effektiewe botsings neem toe. ✓ (5)

5.5

Marking criteria/Nasienriglyne:

- Formula/Formule: $n = \frac{n}{M}$
- Substitute/Vervang 65
- Use ratio/Gebruik verhouding 1 : 2
- Substitute mole acid in rate equation/Vervang mol suur in tempovergelyking
- Substitute time in rate equation/Vervang tyd in tempovergelyking
- Final answer/Finale antwoord: 0,004615 – 0,00463 mol·s⁻¹

$$\begin{aligned} n(\text{Zn}) &= \frac{n}{M} \checkmark \\ &= \frac{1,2}{65} \checkmark \\ &= 0,018 \text{ mol} \end{aligned}$$

$$n(\text{HCl reacted/gereageer}) = 2(0,018) \checkmark = 0,037 \text{ mol}$$

$$\begin{aligned} \text{rate/tempo} &= \frac{\Delta n}{\Delta t} \\ &= \frac{0,037}{8} \checkmark \quad \text{OR/OF} = \frac{-0,037}{8} \\ &= 4,63 \times 10^{-3} \text{ mol} \cdot \text{s}^{-1} \quad \text{OR/OF} - 4,63 \times 10^{-3} \text{ mol} \cdot \text{s}^{-1} \checkmark \end{aligned}$$

Accept range/aanvaar gebied: 0,004615 – 0,00463 mol·s⁻¹

(6)
[15]

QUESTION 6/VRAAG 6

6.1 A reaction is reversible when products can be converted back to reactants. ✓
 'n Reaksie is omkeerbaar wanneer die produkte terug verander kan word na reaktanse. (1)

6.2 No change ✓
 Geen verandering (1)

6.3 **Accept/Aanvaar:**
 6.3.1 Temperature decreases ✓
Temperatuur verlaag (1)

6.3.2 Decrease in temperature decreases the rate of both forward and reverse reactions. ✓
 Verlaging in temperatuur verlaag die tempo van beide die voorwaartse en terugwaartse reaksies.
 Decrease in temperature favours the exothermic reaction. ✓
 Verlaging in temperatuur bevoordeel die eksotermiese reaksie.
 The rate of the reverse (exothermic) reaction is faster or the reverse reaction is favoured./The rate of the forward (endothermic) reaction is slower. ✓
 Die tempo van die terugwaartse (eksotermiese) reaksie is vinniger of die terugwaartse reaksie word bevoordeel./Die tempo van die voorwaartse (endotermiese) reaksie is stadiger. (3)

6.4 **Mark criteria/Nasienriglyne:**

- Correct K_c expression (formulae in square brackets). ✓
 Korrekte K_c uitdrukking (formules in vierkanthakies).
- Divide equilibrium moles by 2 dm^3 . ✓
 Deel aantal mol by ewewig deur 2 dm^3 .
- At equilibrium: $[\text{H}_2] = [\text{I}_2] = x$ /By ewewig: $[\text{H}_2] = [\text{I}_2]$ ✓
- Substitution of concentrations into K_c expression. ✓
 Vervanging van konsentrasies in K_c -uitdrukking.
- Substitution of K_c value. ✓
 Vervanging van K_c -waarde.
- Final answer/Finale antwoord: $2,83 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3}$ ✓

OPTION 1/OPSIE 1At equilibrium/by ewewig: $[H_2] = [I_2]$ ✓

$$K_c = \frac{[H_2][I_2]}{[HI]^2} \checkmark$$

$$\therefore 0,02 \checkmark = \frac{(x)(x)}{\left(\frac{0,04}{2}\right)^2} \checkmark \quad \begin{array}{l} \text{Divide by } 2 \text{ dm}^3 \checkmark \\ \text{Deel deur } 2 \text{ dm}^3 \end{array}$$

$$\therefore x = [H_2] = 2,83 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3} \checkmark \quad (0,0028 \text{ mol} \cdot \text{dm}^{-3})$$

No K_c expression, correct substitution:Geen K_c -uitdrukking, korrekte substitusie:Max./Maks. $\frac{5}{6}$ Wrong K_c expression/Verkeerde K_c -uitdrukking:Max./Maks. $\frac{2}{6}$ **OPTION 2/OPSIE 2**

	HI	H ₂	I ₂	
Initial quantity (mol) Aanvangshoeveelheid (mol)	x	0	0	
Change (mol) Verandering (mol)	x - 0,04	$\frac{x - 0,04}{2}$	$\frac{x - 0,04}{2}$	ratio ✓ verhouding
Quantity at equilibrium (mol)/ Hoeveelheid by ewewig (mol)	0,04	$\frac{x - 0,04}{2}$	$\frac{x - 0,04}{2}$	
Equilibrium concentration (mol·dm ⁻³) Ewewigskonsentrasie (mol·dm ⁻³)	0,02	$\frac{x - 0,04}{4}$	$\frac{x - 0,04}{4}$	Divide by 2 dm ³ ✓ Deel deur 2 dm ³

$$K_c = \frac{[H_2][I_2]}{[HI]^2} \checkmark$$

$$\therefore 0,02 \checkmark = \frac{\left(\frac{x - 0,04}{4}\right)\left(\frac{x - 0,04}{4}\right)}{(0,02)^2} \checkmark$$

$$\therefore x = 0,05$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{5}{6}$ Wrong K_c expression/Verkeerde K_c -uitdrukking: Max./Maks. $\frac{2}{6}$

$$\begin{aligned} [H_2] &= \frac{x - 0,04}{2} \\ &= \frac{0,05 - 0,04}{2} \\ &= 2,83 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3} \checkmark \end{aligned}$$

(6)

6.5

$$\begin{aligned} K_c &= \frac{1}{0,02} \\ &= 50 \checkmark \end{aligned}$$

(1)

6.6

Increases ✓
Vermeerder

(1)

[14]

QUESTION 5/VRAAG 5

5.1 Time/Tyd: (Stop) watch / (Stop)horlosie ✓

Volume: (Gas) syringe / Burette / Measuring cylinder / (Chemical) balance /
Erlenmeyer flask / Graduated flask ✓
(Gas)spruit / Buret / Maatsilinder / (Chemiese) balans /
Erlenmeyer fles / Gegradueerde fles

Notes/Aantekeninge

- Only one mark per type of apparatus. / Slegs een punt per tipe apparaat.

(2)

5.2

5.2.1 t_1 ✓

(1)

5.2.2 t_3 ✓

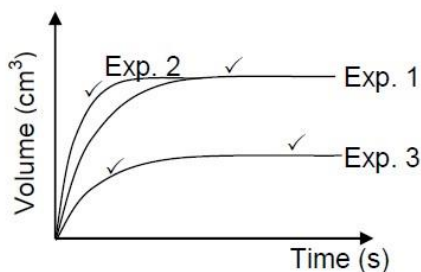
(1)

5.3 Between t_1 and t_2 ✓

Tussen t_1 en t_2

(1)

5.4



Marking criteria/Nasienriglyne

Exp. 2	Initial gradient higher than that of Exp.1. <i>Aanvanklike gradient groter as die van Eksp 1.</i>	✓
	Curve reaches same constant volume as for Exp. 1 (but earlier). <i>Kurwe bereik dieselfde konstante volume as in Eksp 1 (maar gouer).</i>	✓
Exp. 3	Initial gradient lower than that of Exp.1. <i>Aanvanklike gradient kleiner as die van Eksp. 1.</i>	✓
	Curve reaches a smaller constant volume as for Exp. 1 (at a later stage). <i>Kurwe bereik (later) 'n kleiner konstante volume as vir Eksp. 1.</i>	✓

(4)

5.5.1

Marking criteria/Nasienriglyne

- $n(\text{HCl}) = (0,1)(100 \times 10^{-3})$
- Use mole ratio/*Gebruik molverhouding*: $n(\text{Zn}) = \frac{1}{2}n(\text{HCl})$
- Substitute 65 into/ *Vervang 65 in* $n = \frac{m}{M}$
- $n(\text{Zn}_{\text{final/finaal}}) = n(\text{Zn}_{\text{initial/aanvanklik}}) - n(\text{Zn}_{\text{used/gebruik}})$
 $m(\text{Zn}_{\text{final/finaal}}) = m(\text{Zn}_{\text{initial/aanvanklik}}) - m(\text{Zn}_{\text{used/gebruik}})$
- Final answer/*Finale antwoord*: Range/*gebied*: 0,33 g – 0,48 g

OPTION/OPSIE 1

$$\begin{aligned}
 n(\text{HCl}) &= cV \\
 &= (0,1)(100 \times 10^{-3}) \checkmark \\
 &= 0,01 \text{ mol} \\
 &\downarrow \\
 n(\text{Zn reacted/gereageer}): \\
 n(\text{Zn}) &= \frac{1}{2}n(\text{HCl}) \\
 &= \frac{1}{2}(0,01) \checkmark \\
 &= 5 \times 10^{-3} \text{ mol} \\
 &\downarrow \\
 n(\text{Zn reacted/gereageer}): \\
 m(\text{Zn}) &= (5 \times 10^{-3})(65) \checkmark = 0,325 \text{ g} \\
 &\swarrow \\
 m(\text{Zn}_f) &= 0,8 - 0,325 \checkmark \\
 &= 0,48 \text{ g} \checkmark (0,475 \text{ g})
 \end{aligned}$$

OPTION/OPSIE 2

$$\begin{aligned}
 n(\text{HCl}) &= cV \\
 &= (0,1)(100 \times 10^{-3}) \checkmark \\
 &= 0,01 \text{ mol} \\
 &\searrow \\
 n(\text{Zn reacted/gereageer}) &= \frac{1}{2}n(\text{HCl}) \\
 &= \frac{1}{2}(0,01) \checkmark \\
 &= 5 \times 10^{-3} \text{ mol} \\
 n(\text{Zn})_i &= \frac{m}{M} \\
 &= \frac{0,8}{65} \checkmark \\
 &= 1,23 \times 10^{-2} \text{ mol} \\
 &\downarrow \\
 n(\text{Zn})_f &= 1,23 \times 10^{-2} - 5 \times 10^{-3} \checkmark \\
 &= 7,3 \times 10^{-3} \text{ mol} \\
 &\downarrow \\
 m(\text{Zn}) &= nM \\
 &= (7,3 \times 10^{-3})(65) = 0,47 \text{ g} \checkmark
 \end{aligned}$$

(5)

5.5.2 Smaller than / *Kleiner as* ✓(1)
[15]**QUESTION 6/VRAAG 6**6.1 Equal to / *Gelyk aan* ✓

(1)

6.2

$$\begin{aligned}
 K_c &= \frac{[X_3]^2}{[X_2]^3} \checkmark \\
 &= \frac{(0,226)^2}{(0,06)^3} \checkmark \\
 &= 236,46 \checkmark
 \end{aligned}$$

No K_c expression, correct substitution / *Geen K_c - uitdrukking, korrekte substitusie*: Max./Maks. $\frac{3}{4}$ Wrong K_c expression / *Verkeerde K_c -uitdrukking* Max./Maks. $\frac{0}{4}$ If one or more exponents are omitted in substitution step but correct answer obtained: Max $\frac{3}{4}$ *Indien een of meer eksponente uitgelaat by substitusie stap, maar korrekte antwoord verkry: Maks $\frac{3}{4}$*

(4)

6.3

(1)

6.3.1 Increases / *Vermeerder* ✓

6.3.2

- The increase in $[X_3]$ is opposed. / *Change is opposed.* ✓
Die verhoging in $[X_3]$ word teengewerk. / Verandering word teenwerk.
- The reverse reaction is favoured. / X_3 is used / $[X_3]$ decreases. ✓
Die terugwaartse reaksie word bevoordeel. / X_3 word gebruik / $[X_3]$ neem af.

(2)

6.4 Higher than / Hoër as ✓

(1)

6.5 Exothermic / Eksotermies ✓



- The concentration of the product/ $X_3(g)$ is lower / the concentration of the reactant / $X_2(g)$ is higher. ✓
Die konsentrasie van die produkte/ $X_3(g)$ is laer / die konsentrasie van die reaktans / $X_2(g)$ is hoër.
- The increase in temperature favoured the reverse reaction. ✓
Die toename in temperatuur het die terugwaartse reaksie bevoordeel.
- According to Le Chatelier's principle an increase in temperature favours the endothermic reaction. ✓
Volgens Le Chatelier se beginsel bevoordeel 'n toename in temperatuur die endotermiese reaksie.

OR/OF

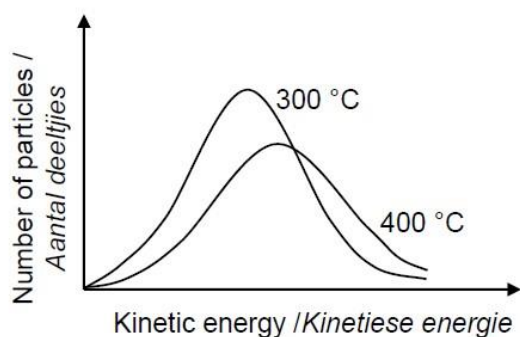


Exothermic / Eksotermies ✓

- $[X_3]$ decreases and $[X_2]$ increases. / $[X_3]$ neem af en $[X_2]$ neem toe. ✓
- K_c decreases if temperature increases. / K_c neem af as die temperatuur afneem. ✓
- Decrease in temperature favoured the forward reaction. / Verlaging in temperatuur het die voorwaartse reaksie bevoordeel. ✓

(4)

6.6



Marking criteria/Nasienriglyne	
Peak of curve at 400 °C lower than at 300 °C and shifted to the right. <i>Piek van kurwe by 400 °C laer as by 300 °C en skuif na regs.</i>	✓
Curve at 400 °C has larger area at the higher E_k . <i>Kurwe by 400 °C het groter oppervlak by hoë E_k.</i>	✓

(2)
[15]

QUESTION 5/VRAAG 5

5.1 **ONLY ANY TWO OF/SLEGS ENIGE TWEE VAN:**

- Increase temperature./Verhoog die temperatuur. ✓
- Increase concentration of acid./Verhoog die konsentrasie van die suur. ✓
- Add a catalyst./Voeg 'n katalisator by.

(2)

5.2 **ONLY ANY ONE OF/SLEGS ENIGE EEN VAN:**

- Change in concentration of products/reactants ✓ per (unit) time. ✓
Verandering in konsentrasie van produkte/reaktanse per (eenheids)tyd.
- Rate of change in concentration. ✓✓
Tempo van verandering in konsentrasie.
- Change in amount/number of moles/volume/mass of products or reactants
per (unit) time.
Verandering in hoeveelheid/getal mol/volume/massa van produkte of
reaktanse per (eenheids)tyd.
- Amount/number of moles/volume/mass of products formed or reactants
used per (unit) time.
Hoeveelheid/getal mol/volume/massa van produkte gevorm of reaktanse
gebruik per (eenheids)tyd.

(2)

5.3

5.3.1

$$\begin{aligned}\text{average rate / gemiddelde tempo} &= -\frac{\Delta c}{\Delta t} \\ &= -\frac{(1,45 - 1,90)}{(15 - 0)} \checkmark \\ &= 0,03 \text{ (mol} \cdot \text{dm}^{-3}) \cdot \text{min}^{-1} \checkmark\end{aligned}$$

Notes/Aantekeninge

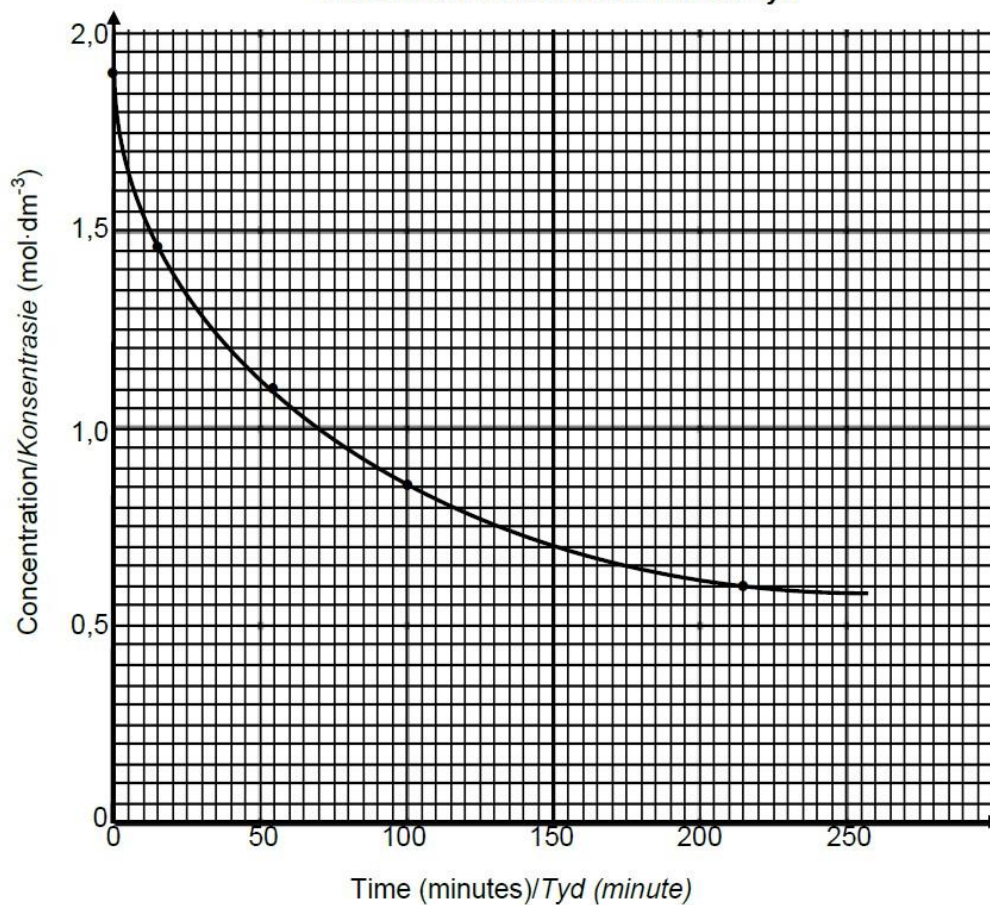
Accept /Aanvaar:

- If unit omitted./Indien eenheid weggelaat is.
- Rate/Tempo = $\frac{\Delta c}{\Delta t}$
 $= \frac{1,45 - 1,90}{15 - 0}$
 $= -0,03 \text{ (mol} \cdot \text{dm}^{-3}) \cdot \text{min}^{-1}$

(3)

5.3.2

Graph of concentration versus time
Grafiek van konsentrasie teenoor tyd



Marking criteria/Nasienriglyne	
Four points correctly plotted./Vier punte korrek gestip.	✓✓
Curve drawn as shown./Kurwe getrek soos getoon.	✓

(3)

5.3.3 POSITIVE MARKING FROM QUESTION 5.3.2.

POSITIEWE NASIEN VANAF VRAAG 5.3.2.

1,2 mol·dm⁻³ ✓

Accept range/Aanvaar gebied: 1,15 to/tot 1,25 mol·dm⁻³

(1)

- 5.3.4
- Concentration of reactants decreases. ✓
Konsentrasie van reaktanse neem af.
 - Less particles per unit volume. ✓
Minder deeltjies per volume.
 - Less effective collisions per unit time. ✓
Minder effektiewe botsings per eenheidstyd.

(3)

5.3.5

Marking criteria/Nasienriglyne

- Use $n = cV$ to calculate $\Delta n/n(\text{initial})$ & $n(\text{final})$.
Gebruik $n = cV$ om $\Delta n/n(\text{aanvanklik})$ & $n(\text{finaal})$ te bereken.
- $\Delta n(\text{HCl}) = n(\text{final/finaal}) - n(\text{initial/aanvanklik})$.
OR/OF
 $\Delta c(\text{HCl}) = c(\text{final/finaal}) - c(\text{initial/aanvanklik})$
- Use ratio/*Gebruik verhouding* $n(\text{CH}_3\text{Cl}) : n(\text{HCl}) = 1 : 1$
- Substitute/*Vervang* $50,5 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$.
- Final answer/*Finale antwoord*: 3,54–4,0 g.

OPTION 1/OPSIE 1

Mol initially/begin:

$$n(\text{HCl}) = cV \checkmark$$

$$= (1,9)(60 \times 10^{-3}) \checkmark$$

$$= 0,11 \text{ mol (0,114)}$$

Mol final/finaal:

$$n(\text{HCl}) = cV$$

$$= (0,6)(60 \times 10^{-3})$$

$$= 0,04 \text{ mol (0,036)}$$

$$\Delta n(\text{HCl}) = 0,04 - 0,11 \checkmark$$

$$= -0,07 \text{ mol (0,078 mol)}$$

$$\Delta n(\text{HCl}) = 0,07 \text{ mol (0,078)}$$

$$n(\text{formed/gevorm}) = n(\text{reacted/reageer})$$

$$n(\text{CH}_3\text{Cl}) = n(\text{HCl}) \checkmark$$

$$= 0,07 \text{ mol}$$

$$m(\text{CH}_3\text{Cl}) = nM$$

$$= (0,07)(50,5) \checkmark$$

$$= 3,54 \text{ g} \checkmark$$

Accept range/*Aanvaar gebied*:
3,54 – 4,0 g

OPTION 2/OPSIE 2

$$\Delta c(\text{HCl}) = 0,6 - 1,9 \checkmark$$

$$= -1,3$$

$$= 1,3 \text{ mol} \cdot \text{dm}^{-3}$$

$$\Delta n(\text{HCl}) = \Delta cV$$

$$= (1,3)(60 \times 10^{-3}) \checkmark$$

$$= 0,08 \text{ mol (0,078)}$$

$$n(\text{formed/gevorm}) = n(\text{reacted/reageer})$$

$$n(\text{CH}_3\text{Cl}) = n(\text{HCl}) \checkmark$$

$$= 0,08 \text{ mol}$$

$$m(\text{CH}_3\text{Cl}) = nM$$

$$= (0,08)(50,5) \checkmark$$

$$= 4 \text{ g} \checkmark$$

Accept range/*Aanvaar gebied*:
3,54 – 4,0 g

(5)
[19]

QUESTION 6/VRAAG 6

6.1

<u>OPTION 1/OPSIE 1</u>	<u>OPTION 2/OPSIE 2</u>
$c = \frac{m}{MV} \checkmark$ $= \frac{2,2}{(44)(5)} \checkmark$ $= 0,01 \text{ mol} \cdot \text{dm}^{-3} \checkmark$	$n = \frac{m}{M}$ $= \frac{2,2}{44} \checkmark$ $= 0,05 \text{ mol}$ $c = \frac{n}{V}$ $= \frac{0,05}{5} \checkmark$ $= 0,01 \text{ mol} \cdot \text{dm}^{-3} \checkmark$

Both formulae/
albei formules

(4)

6.2

For equilibrium, a forward and a reverse reaction are needed. ✓
Vir ewewig word 'n voorwaartse en terugwaartse reaksie benodig.

OR/OF

Without CaO(s), the reverse reaction is not possible.
Sonder CaO(s) is die terugwaartse reaksie nie moontlik nie.

OR/OF

If only CO₂ is present, the reverse reaction cannot take place.
Indien slegs CO₂ teenwoordig is, kan die terugwaartse reaksie nie plaasvind nie.

(1)

6.3

CO₂ is a gas and will escape if the container is not sealed. ✓
CO₂ is 'n gas en sal ontsnap as die houer nie geseël is nie.

(1)

6.4

CALCULATIONS USING NUMBER OF MOLES:
BEREKENINGE WAT GETAL MOL GEBRUIK:

Marking guidelines/Nasienglyne

- K_c expression/K_c-uitdrukking ✓
- Substitute K_c value./Vervang K_c-waarde. ✓
- n(CO₂) or m(CO₂) at equilibrium/n(CO₂) of m(CO₂) by ewewig. ✓
- Change in n(CO₂) or m(CO₂)/Verandering in n(CO₂) of m(CO₂) ✓
- Mol ratio/Molverhouding: n(CaCO₃) : n(CO₂) = 1 : 1 ✓
- n(CaCO₃) x 100 ✓
- Final answer/Finale antwoord: 0,4 g ✓

OPTION 1/OPSIE 1**POSITIVE MARKING FROM QUESTION 6.2.****POSITIEWE NASIEN VANAF VRAAG 6.2.**

$$K_c = [\text{CO}_2] \checkmark$$

$$= 0,0108$$

$$\therefore [\text{CO}_2] = 0,0108 \text{ (mol}\cdot\text{dm}^{-3}) \checkmark$$

$$n(\text{CO}_2 \text{ at equilibrium/by ewewig}) = cV$$

$$= (0,0108)(5) \checkmark$$

$$= 0,054 \text{ mol}$$

$$n(\text{CO}_2 \text{ formed/gevorm}) = n(\text{CO}_2 \text{ at equilibrium/by ewewig}) - n(\text{CO}_2 \text{ initially/begin})$$

$$= 0,054 - 0,05 \checkmark$$

$$= 0,004 \text{ mol}$$

$$n(\text{CaCO}_3) = n(\text{CO}_2 \text{ formed}) = 0,004 \text{ mol} \checkmark$$

$$m(\text{CaCO}_3) = nM$$

$$= (0,004)(100) \checkmark$$

$$= 0,4 \text{ g} \checkmark$$

OPTION 2/OPSIE 2**POSITIVE MARKING FROM QUESTION 6.2.****POSITIEWE NASIEN VANAF VRAAG 6.2.**

$$K_c = [\text{CO}_2] \checkmark$$

$$= 0,0108 \checkmark$$

$$\therefore [\text{CO}_2] = 0,0108 \text{ (mol}\cdot\text{dm}^{-3})$$

	CaCO ₃	CaO	CO ₂
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	0	0	0,05
Change (mol) <i>Verandering (mol)</i>	0,004	x	0,004 ✓
Quantity at equilibrium (mol) <i>Hoeveelheid by ewewig (mol)</i>			0,054 ✓
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>			0,0108

✓ Ratio/
Verhouding

$$m(\text{CaCO}) = nM$$

$$= (0,004)(100) \checkmark$$

$$= 0,4 \text{ g} \checkmark$$

OPTION 3/OPSIE 3**POSITIVE MARKING FROM QUESTION 6.2.****POSITIEWE NASIEN VANAF VRAAG 6.2.**

	CaCO ₃	CaO	CO ₂	✓ Ratio/ Verhouding
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	0	0	0,05	
Change (mol) <i>Verandering (mol)</i>	x	x	x ✓	
Quantity at equilibrium (mol) <i>Hoeveelheid by ewewig (mol)</i>			0,05 + x ✓	
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>			$\frac{0,05 + x}{5}$	

$$K_c = [\text{CO}_2] \checkmark$$

$$\therefore 0,0108 \checkmark = \frac{0,05 + x}{5}$$

$$\therefore x = 0,004$$

$$\begin{aligned} m(\text{CaCO}_3) &= nM \\ &= (0,004)(100) \checkmark \\ &= 0,4 \text{ g} \checkmark \end{aligned}$$

CALCULATIONS USING CONCENTRATIONS:**BEREKENINGE WAT KONSENTRASIE GEBRUIK:****OPTION 4/OPSIE 4****POSITIVE MARKING FROM QUESTION 6.2.****POSITIEWE NASIEN VANAF VRAAG 6.2.**

$$K_c = [\text{CO}_2] \checkmark$$

$$= 0,0108 \checkmark$$

$$\therefore [\text{CO}_2] = 0,0108 \text{ (mol·dm}^{-3}\text{)}$$

$$\begin{aligned} \Delta c(\text{CO}_2) &= c(\text{CO}_2 \text{ at equilibrium/by ewewig}) - c(\text{CO}_2 \text{ initially/begin}) \\ &= 0,0108 - 0,01 \checkmark \\ &= 8 \times 10^{-4} \text{ mol·dm}^{-3} \end{aligned}$$

$$\begin{aligned} n(\text{CO}_2 \text{ formed/gevorm}) &= cV \\ &= (8 \times 10^{-4})(5) \checkmark \\ &= 4 \times 10^{-3} \text{ mol} \end{aligned}$$

$$n(\text{CaCO}_3 \text{ formed/gevorm}) = n(\text{CO}_2 \text{ formed/gevorm}) = 4 \times 10^{-3} \text{ mol} \checkmark$$

$$\begin{aligned} m(\text{CaCO}_3) &= nM \\ &= (4 \times 10^{-3})(100) \checkmark \\ &= 0,4 \text{ g} \checkmark \end{aligned}$$

CALCULATIONS USING MASS:
BEREKENINGE WAT MASSA GEBRUIK:

OPTION 5/OPSIE 5

$$K_c = [\text{CO}_2] \checkmark$$

$$= 0,0108 \checkmark$$

$$\therefore [\text{CO}_2] = 0,0108 \text{ (mol} \cdot \text{dm}^{-3})$$

$$m(\text{CO}_2) = cMV$$

$$= (0,0108)(44)(5) \checkmark$$

$$= 2,376 \text{ g}$$

$$\Delta m(\text{CO}_2) = m(\text{CO}_2 \text{ at equilibrium/by ewewig}) - m(\text{CO}_2 \text{ initially/begin})$$

$$= 2,376 - 2,2 \checkmark$$

$$= 0,176 \text{ g}$$

$$n(\text{CO}_2 \text{ formed / gevorm}) = \frac{m}{M}$$

$$= \frac{0,176}{44}$$

$$= 4 \times 10^{-3} \text{ mol}$$

$$n(\text{CaCO}_3 \text{ formed/gevorm}) = n(\text{CO}_2 \text{ formed/gevorm}) = 4 \times 10^{-3} \text{ mol} \checkmark$$

$$m(\text{CaCO}_3) = nM$$

$$= (4 \times 10^{-3})(100) \checkmark$$

$$= 0,4 \text{ g} \checkmark$$

(7)

6.5

6.5.1 Remains the same/Bly dieselfde $\checkmark$

(1)

6.5.2 Decreases/Neem af $\checkmark$

(1)

6.6 Endothermic/Endotermies $\checkmark$



- K_c decreases at lower temperature./ K_c neem af by laer temperatuur. $\checkmark$
- Therefore the product of the concentration of products decreases./The reverse reaction is favoured. $\checkmark$
Daarom neem die produk van die konsentrasie van die produkte af./die terugwaartse reaksie word bevoordeel.
- A decrease in temperature favours the exothermic reaction. $\checkmark$
Afname in temperatuur bevoordeel die eksotermiese reaksie.

OR/OF

Endothermic/Endotermies $\checkmark$

- K_c increases with increase in temperature. $\checkmark$
 K_c neem toe met toename in temperatuur.
- Increase in temperature favours the forward reaction. $\checkmark$
Toename in temperatuur bevoordeel die voorwaartse reaksie.
- Increase in temperature favours the endothermic reaction. $\checkmark$
Toename in temperatuur bevoordeel die endotermiese reaksie.

(4)
[19]

5.1.3 **Marking criteria/Nasienriglyne**

- Dotted line (---) on graph in QUESTION 5.1.2 showing lower energy for activated complex. ✓
Stippellyn (---) op grafiek in VRAAG 5.1.2 wat laer energie vir geaktiveerde kompleks toon.
- Dotted curve starts at/above energy of reactants and ends at/above energy of products on the inside of the original curve. ✓
Stippellyn kurwe begin by/bokant energie van reaktanse en eindig by/bokant energie van produkte aan die binnekant van die oorspronklike kurwe.

Note/Aantekening:

Allocate marks only if curve for either exothermic or endothermic reaction drawn in QUESTION 5.1.2.

Ken punte slegs toe indien kurwe vir endotermiese of eksotermiese reaksie in VRAAG 5.1.2 geteken is.

(2)

5.1.4

- A catalyst provides an alternative pathway of lower activation energy. ✓
'n Katalisator voorsien 'n alternatiewe pad van laer aktiveringsenergie.
- More molecules have sufficient / enough (kinetic) energy. ✓
Meer molekule het voldoende / genoeg (kinetiese) energie.
OR/OF
More molecules have kinetic energy equal to or greater than the activation energy.
Meer molekule het kinetiese energie gelyk aan of groter as die aktiveringsenergie.
- More effective collisions per unit time / second. ✓
Meer effektiewe botsings per eenheidstyd / sekonde.
OR/OF
Rate / frequency of effective collisions increases.
Tempo / frekwensie van effektiewe botsings neem toe.

(3)

5.2

5.2.1

$$\begin{aligned}\text{Ave rate/Gem. tempo} &= \frac{\Delta V}{\Delta t} \\ &= \frac{52 - 16}{40 - 10} \checkmark \\ &= 1,2 \text{ (dm}^3 \cdot \text{s}^{-1}) \checkmark\end{aligned}$$

Accept/Aanvaar:

- Volume range/gebied:
16 to/tot 17 cm³
- Answer range/Antwoordgebied:
1,167 to 1,2 dm³·s⁻¹

(3)

5.2.2

Marking criteria/Nasienriglyne:

- $V(\text{O}_2) = 60 \text{ dm}^3$ AND/EN divide volume by 24./deel volume deur 24 ✓
- Use ratio/Gebruik verhouding: $n(\text{H}_2\text{O}_2) = 2n(\text{O}_2) = 1:2$ ✓
- Use $34 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$ or in ratio calculation. ✓

Gebruik $34 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$ of in verhoudingsberekening.

- Final answer/Finale antwoord: 170 g ✓

OPTION 1/OPSIE 1

$$\begin{aligned}
 n(\text{O}_2) &= \frac{V}{V_M} \\
 &= \frac{60}{24} \checkmark \\
 &= 2,5 \text{ mol} \\
 n(\text{H}_2\text{O}_2) &= 2n(\text{O}_2) \\
 &= 2(2,5) \checkmark \\
 &= 5 \text{ mol} \\
 n(\text{H}_2\text{O}_2) &= \frac{m}{M} \\
 \therefore 5 &= \frac{m}{34} \checkmark \\
 \therefore m &= 170 \text{ g} \checkmark
 \end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned}
 24 \text{ dm}^3 &: 1 \text{ mol} \\
 60 \text{ dm}^3 &: 2,5 \text{ mol} \checkmark \\
 n(\text{H}_2\text{O}_2) &= 2n(\text{O}_2) \\
 &= 2(2,5) \checkmark \\
 &= 5 \text{ mol} \\
 34 \text{ g} \checkmark &: 1 \text{ mol} \\
 x &: 5 \text{ mol} \\
 x &= 170 \text{ g} \checkmark
 \end{aligned}$$

OPTION 3/OPSIE 3

$$\begin{aligned}
 n(\text{O}_2) &= \frac{V}{V_M} \\
 &= \frac{60}{24} \checkmark \\
 &= 2,5 \text{ mol} \\
 n(\text{O}_2) &= \frac{m}{M} \\
 \therefore 2,5 &= \frac{m}{32} \\
 \therefore m &= 80 \text{ g} \\
 \begin{array}{l} \checkmark (34) \text{ g} \checkmark \text{ H}_2\text{O}_2 \dots\dots\dots 32 \text{ g O}_2 \\ x \text{ g H}_2\text{O}_2 \dots\dots\dots 80 \text{ g O}_2 \end{array} \\
 m(\text{H}_2\text{O}_2) &= 170 \text{ g} \checkmark
 \end{aligned}$$

(4)

5.2.3 Equal to / Gelyk aan ✓

(1)

5.3

5.3.1 Q ✓

(1)

5.3.2 P ✓

(1)

[20]

QUESTION 6/VRAAG 6

- 6.1 The stage in a chemical reaction when the rate of forward reaction equals the rate of reverse reaction. ✓✓ (2 marks or no marks)

Die stadium in 'n chemiese reaksie wanneer die tempo van die voorwaartse reaksie is gelyk aan die tempo van die terugwaartse reaksie. ✓✓
(2 punte of geen punte nie)

OR/OF

The state where the concentrations / quantities of reactants and products remain constant.

Die toestand wanneer die konsentrasies / hoeveelhede van reaktanse en produkte konstant bly.

(2)

6.2

- 6.2.1 Remains the same / Bly dieselfde ✓

(1)

- 6.2.2 Decreases / Verlaag ✓



When the temperature is increased the reaction that will oppose this increase / decrease the temperature will be favoured. ✓
Wanneer die temperatuur toeneem, sal die reaksie wat hierdie toename teenwerk / die temperatuur laat afneem bevoordeel word.

OR/OF

The forward reaction is exothermic. / Die voorwaartse reaksie is eksotermies.

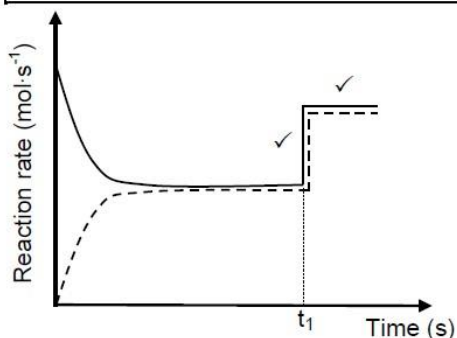
- An increase in temperature favours the endothermic reaction. ✓
'n Toename in temperatuur bevoordeel die endotermiese reaksie.
- The reverse reaction is favoured. ✓
Die terugwaartse reaksie word bevoordeel.

(4)

6.3

Marking criteria/Nasienriglyne:

- Vertical parallel lines show a sudden increase in rate of both forward and reverse reactions. / Vertikale parallelle lyne wys 'n skielike toename in reaksietempo van beide voorwaartse en terugwaartse reaksies. ✓
- Horizontal parallel lines showing a constant higher rate for both forward and reverse catalysed reactions after time t_1 . / Horizontale parallelle lyne wat 'n konstante hoër tempo aantoon vir beide voorwaartse en terugwaartse gekataliseerde reaksies na t_1 . ✓



(2)

CALCULATIONS USING NUMBER OF MOLES BEREKENINGE WAT AANTAL MOL GEBRUIK

Marking criteria/Nasinriqlyne:

- Use/Gebruik $M(\text{PbS}) = 239 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$ or in ratio calculation/ of in verhoudingsberekening. ✓
- Use ratio/Gebruik verhouding: $n(\text{H}_2\text{S})_{\text{equil/ewewig}} = n(\text{PbS})$ ✓
- $n(\text{H}_2\text{S})_{\text{formed/gevorm}} = n(\text{H}_2\text{S})_{\text{equilibrium/ewewig}}$ ✓
- **USING ratio/GEBRUIK verhouding:** $\text{H}_2 : \text{H}_2\text{S} = 1 : 1$ ✓
- $n(\text{H}_2)_{\text{equilibrium/ewewig}} = n(\text{H}_2)_{\text{initial/aanvanklik}} - n(\text{H}_2)_{\text{formed/gevorm}}$ ✓
- Divide equilibrium $n(\text{H}_2\text{S})$ & $n(\text{H}_2)$ by 2 dm^3 . ✓
Deel $n(\text{H}_2\text{S})$ & $n(\text{H}_2)$ deur 2 dm^3
- Correct K_c expression ✓
Korrekte K_c uitdrukking.
- Substitution of concentrations into K_c expression. ✓
Vervanging van konsentrasies in K_c -uitdrukking.
- Final answer/Finale antwoord: 0,07 ✓
NB/L.W.: If not rounded/Indien nie afgerond nie: 0,067

OPTION 1/OPSIE 1

$$n(\text{PbS}) = \frac{m}{M} = \frac{2,39}{239} = 0,01 \text{ mol}$$

$$n(\text{H}_2\text{S})_{\text{equilibrium/by ewewig}} = n(\text{PbS}) \checkmark = 0,01 \text{ mol}$$

	H_2	H_2S	
Initial quantity (mol) Aanvangshoeveelheid (mol)	0,16	0	
Change (mol) Verandering (mol)	0,01	0,01 ✓	ratio ✓ verhouding
Quantity at equilibrium (mol)/ Hoeveelheid by ewewig (mol)	0,15 ✓	0,01	
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$) Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	0,075	0,005	divide by 2 ✓ deel deur 2

$$K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2]}$$

$$= \frac{0,005}{0,075}$$

$$= 0,067 \approx 0,07 \checkmark$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{8}{9}$

Wrong K_c expression /Verkeerde K_c -uitdrukking:
Max./Maks. $\frac{6}{9}$

IF/INDIEN: $[\text{S}] = 1$ in $K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2][\text{S}]}$

No mark for K_c expression, but continue marking substitution and answer./Geen punt vir K_c -uitdrukking, maar gaan voort om substitusie en antwoord na te sien.

OPTION 2/OPSIE 2

$$n(\text{PbS}) = \frac{m}{M}$$

$$= \frac{2,39}{239} \checkmark$$

$$= 0,01 \text{ mol}$$

$$n(\text{H}_2\text{S})_{\text{reacted/gerageer}} = n(\text{PbS}) \checkmark = 0,01 \text{ mol}$$

$$= n(\text{H}_2\text{S})_{\text{equilibrium/ewewig}}$$

$$n(\text{H}_2\text{S})_{\text{formed/gevorm}} = n(\text{H}_2\text{S})_{\text{equilibrium/ewewig}} - n(\text{H}_2\text{S})_{\text{initial/aanvanklik}}$$

$$= 0,01 - 0 \checkmark$$

$$= 0,01 \text{ mol}$$

$$n(\text{H}_2)_{\text{reacted/gerageer}} = n(\text{H}_2\text{S})_{\text{formed/gevorm}} \checkmark = 0,01 \text{ mol}$$

$$n(\text{H}_2)_{\text{equilibrium/ewewig}} = n(\text{H}_2)_{\text{initial/aanvanklik}} - n(\text{H}_2)_{\text{reacted/gerageer}}$$

$$= 0,16 - 0,01 \checkmark$$

$$= 0,15 \text{ mol}$$

$$c(\text{H}_2) = \frac{n}{V}$$

$$= \frac{0,15}{2}$$

$$= 0,075 \text{ mol} \cdot \text{dm}^{-3}$$

$$c(\text{H}_2\text{S}) = \frac{n}{V}$$

$$= \frac{0,01}{2} \checkmark$$

$$= 0,005 \text{ mol} \cdot \text{dm}^{-3}$$

$$K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2]} \checkmark$$

$$= \frac{0,005}{0,075} \checkmark$$

$$= 0,067 \approx 0,07 \checkmark$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{8}{9}$

Wrong K_c expression / Verkeerde K_c -uitdrukking:
Max./Maks. $\frac{6}{9}$

IF/INDIEN: $[\text{S}] = 1$ in $K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2][\text{S}]}$

No mark for K_c expression, but continue marking substitution and answer./Geen punt vir K_c -uitdrukking, maar gaan voort om substitusie en antwoord na te sien.

OPTION 3/OPSIE 3

	H ₂	H ₂ S	
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	0,16	0	
Change (mol) <i>Verandering (mol)</i>	x	x ✓	ratio ✓ verhouding
Quantity at equilibrium (mol)/ <i>Hoeveelheid by ewewig (mol)</i>	0,16 - x ✓	x	
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	$\frac{0,16 - x}{2}$	$\frac{x}{2}$	divide by 2 ✓ deel deur 2

$$n(\text{PbS}) = \frac{m}{M}$$

$$= \frac{2,39}{239} \checkmark$$

$$= 0,01 \text{ mol}$$

$$n(\text{H}_2\text{S})_{\text{equilibrium/by ewewig}} = n(\text{PbS}) \checkmark \therefore x = 0,01 \text{ mol}$$

$$[\text{H}_2]_{\text{equilibrium/by ewewig}} = \frac{0,16 - 0,01}{2} = 0,075 \text{ mol} \cdot \text{dm}^{-3}$$

$$[\text{H}_2\text{S}]_{\text{equilibrium/by ewewig}} = \frac{0,01}{2} = 0,005 \text{ mol} \cdot \text{dm}^{-3}$$

$$K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2]} \checkmark$$

$$= \frac{0,005}{0,075} \checkmark$$

$$= 0,067 \approx 0,07 \checkmark$$

No K_c expression, correct substitution/Geen K_c-uitdrukking, korrekte substitusie: Max./Maks. $\frac{8}{9}$

Wrong K_c expression /Verkeerde K_c-uitdrukking: Max./Maks. $\frac{6}{9}$

IF/INDIEN: $[\text{S}] = 1$ in $K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2][\text{S}]}$

No mark for K_c expression, but continue marking substitution and answer./Geen punt vir K_c-uitdrukking, maar gaan voort om substitusie en antwoord na te sien.

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Marking criteria/Nasinriqlyne:

- Use/Gebruik $M(\text{PbS}) = 239 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$ or in ratio calculation/ of in verhoudingsberekening. ✓
- Use ratio/Gebruik verhouding: $n(\text{H}_2\text{S})_{\text{equilibrium/ewewig}} = n(\text{PbS})$ ✓
- Divide equilibrium $n(\text{H}_2\text{S})_{\text{equilibrium}}$ & $n(\text{H}_2)_{\text{initial}}$ by 2 dm^3 . ✓
Deel $n(\text{H}_2\text{S})_{\text{ewewig}}$ & $n(\text{H}_2)_{\text{aanvanklik}}$ deur 2 dm^3
- $[\text{H}_2\text{S}]_{\text{formed/gevorm}} = [\text{H}_2\text{S}]_{\text{equilibrium/ewewig}}$ ✓
- **USING** ratio/**GEBRUIK** verhouding: $\text{H}_2 : \text{H}_2\text{S} = 1 : 1$ ✓
- $[\text{H}_2]_{\text{equilibrium/ewewig}} = [\text{H}_2]_{\text{initial/aanvanklik}} - [\text{H}_2]_{\text{formed/gevorm}}$ ✓
- Correct K_c expression ✓
Korrekte K_c uitdrukking.
- Substitution of concentrations into K_c expression. ✓
Vervanging van konsentrasies in K_c -uitdrukking.
- Final answer/Finale antwoord: 0,07 ✓
Note/Let Wel: If not rounded/Indien nie afgerond nie: 0,067

OPTION 4/OPSIE 4

$$n(\text{PbS}) = \frac{m}{M} = \frac{2,39}{239} = 0,01 \text{ mol}$$

$$n(\text{H}_2\text{S})_{\text{equilibrium/by ewewig}} = n(\text{PbS}) \checkmark = 0,01 \text{ mol}$$

	H_2	H_2S
Initial concentration/Aanvangskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	$\frac{0,16}{2} = 0,08$	0
Change in concentration/Verandering in konsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	0,005	0,005 ✓
Equilibrium concentration/Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	0,075	$\frac{0,01}{2} = 0,005$

$$K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2]}$$

$$= \frac{0,005}{0,075}$$

$$= 0,067 \approx 0,07$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{8}{9}$

Wrong K_c expression /Verkeerde K_c -uitdrukking:
 Max./Maks. $\frac{6}{9}$

IF/INDIEN: $[\text{S}] = 1$ in $K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2][\text{S}]}$

No mark for K_c expression, but continue marking substitution and answer./Geen punt vir K_c -uitdrukking, maar gaan voort om substitusie en antwoord na te sien.

OPTION 5/OPSIE 5

$$n(\text{PbS}) = \frac{m}{M}$$

$$= \frac{2,39}{239}$$

$$= 0,01 \text{ mol}$$

$$n(\text{H}_2\text{S})_{\text{equilibrium/by ewewig}} = n(\text{PbS}) \checkmark = 0,01 \text{ mol}$$

$$[\text{H}_2\text{S}]_{\text{equilibrium/by ewewig}} = \frac{n}{V}$$

$$= \frac{0,01}{2}$$

$$= 0,005 \text{ mol} \cdot \text{dm}^{-3}$$

$$[\text{H}_2]_{\text{initial/aanvanklik}} = \frac{n}{V}$$

$$= \frac{0,16}{2}$$

$$= 0,08 \text{ mol} \cdot \text{dm}^{-3}$$

$$[\text{H}_2\text{S}]_{\text{formed/gevorm}} = [\text{H}_2\text{S}]_{\text{equilibrium/by ewewig}} - [\text{H}_2\text{S}]_{\text{initial/aanvanklik}}$$

$$= 0,005 - 0 \checkmark$$

$$= 0,005 \text{ mol} \cdot \text{dm}^{-3}$$

$$[\text{H}_2]_{\text{reacted/gereageer}} = [\text{H}_2\text{S}]_{\text{formed/gevorm}} \checkmark = 0,005 \text{ mol}$$

$$[\text{H}_2]_{\text{equilibrium/ewewig}} = [\text{H}_2]_{\text{initial/aanvanklik}} - [\text{H}_2]_{\text{reacted/gereageer}}$$

$$= 0,08 - 0,005 \checkmark$$

$$= 0,075 \text{ mol}$$

$$K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2]}$$

$$= \frac{0,005}{0,075}$$

$$= 0,067 \approx 0,07$$

No K_c expression, correct substitution/*Geen K_c -uitdrukking, korrekte substitusie*: Max./Maks. $\frac{8}{9}$

Wrong K_c expression /*Verkeerde K_c -uitdrukking*: Max./Maks. $\frac{6}{9}$

IF/INDIEN: $[\text{S}] = 1$ in $K_c = \frac{[\text{H}_2\text{S}]}{[\text{H}_2][\text{S}]}$

No mark for K_c expression, but continue marking substitution and answer./*Geen punt vir K_c -uitdrukking, maar gaan voort om substitusie en antwoord na te sien.*

(9)
[18]

QUESTION 5/VRAAG 5

5.1 ANY TWO/ENIGE TWEE:

- Increase temperature of HCl. / *Toename in temperatuur van HCl.* ✓
- Add a catalyst. / *Voeg 'n katalisator by.* ✓
- Increase the concentration of HCl. / *Toename in konsentrasie van HCl.*
- Increase the state of division of CuCO₃. / *Toename in toestand van verdeeldheid van CuCO₃.*
- Agitation / Stirring / *Roer mengsel.*

(2)

5.2 Accepted range / *Aanvaarde gebied:* 42 s to 50 s ✓

(1)

5.3

5.3.1 average / *gem. tempo* = $-\frac{\Delta m}{\Delta t}$
 $= -\frac{(169,76 - 170,00)}{(20 - 0)}$ ✓
 $= 0,012(\text{g} \cdot \text{s}^{-1})$ ✓

If answer is negative (minus 1 mark) / *Indien antwoord negatief is (minus 1 punt)*

(3)

5.3.2 Pure sample/Suiwer monster:

$$m(\text{CO}_2)_{\text{formed/gevorm}} = 170,00 - 169,73$$
 ✓
 $= 0,27 \text{ g}$

Impure sample/Onsuiwer monster:

$$m(\text{CO}_2)_{\text{formed/gevorm}} = 170,00 - 169,78$$
 ✓
 $= 0,22 \text{ g}$

$$\% \text{Purity/suiverheid} = \frac{0,22}{0,27} \times 100$$
 ✓
 $= 81,48\%$ ✓

(4)

5.3.3 **POSITIVE MARKING FROM QUESTION 5.3.2.**
POSITIEWE NASIEN VAN VRAAG 5.3.2.

$$n(\text{CO}_2)_{\text{formed/ gevorm}} = \frac{m}{M}$$

$$= \frac{0,27}{44}$$
 ✓
 $= 6,13 \times 10^{-3} \text{ mol}$

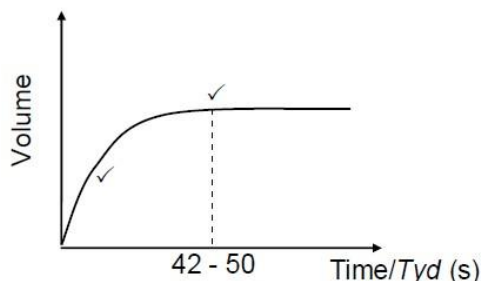
$$n(\text{CO}_2) = \frac{V}{V_m}$$

$$6,13 \times 10^{-3} = \frac{V}{22,4}$$
 ✓

$$V = 0,137 \text{ dm}^3$$
 ✓

(3)

5.4 **POSITIVE MARKING FROM QUESTION 5.2.**
POSITIEWE NASIEN VAN VRAAG 5.2.



Marking criteria for sketch graph:

Nasiemriglyne vir sketsgrafiek:

Graph drawn from origin with decreasing gradient.
Grafiek geteken uit oorsprong met afnemende gradiënt.

✓

Constant volume after (42 -50) s.or graph stops at (42 -50) s
Konstante volume na (42 - 50) s of grafiek stop by (42 - 50) s

✓

If no labels on axes: minus 1./Indien geen benoemings op asse: minus 1

(2)
[15]

QUESTION 6/VRAAG 6

- 6.1 Amount / number of moles / volume of (gas) reactants equals amount/number of moles/volume of (gas) products. ✓
Hoeveelheid / Aantal mol van gas-reaktante is gelyk aan die hoeveelheid/getal mol gasprodukte.

OR/OF

A change in pressure will change the concentration of the reactants and products equally.

'n Verandering in die druk sal die konsentrasie van die reaktante en produkte dieselfde verander.

(1)

6.2 **CALCULATIONS USING NUMBER OF MOLES**
BEREKENINGE WAT GETAL MOL GEBRUIK

Mark allocation/Puntetoekenning:

- Divide equilibrium amounts of H_2 and I_2 by 2 dm^3 . ✓
Deel ewewigshoeveelhede van H_2 en I_2 deur 2 dm^3 .
- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c -uitdrukking (formules in vierkanthakies).
- Substitution of equilibrium concentrations into K_c expression. ✓
Vervanging van ewewigskonsentrasies in K_c -uitdrukking.
- Substitution of K_c value/Vervanging van K_c -waarde. ✓
- Change in $n(HI) = n(HI)$ at equilibrium). ✓
Verandering in $n(HI) = n(HI)$ by ewewig
- **USING** ratio/**GEBRUIK** verhouding: $H_2 : I_2 ; HI = 1 : 1 : 2$ ✓
- Initial $n(I_2) = \text{equilibrium } n(I_2) + \text{change in } n(I_2)$ ✓
Aanvanklike $n(I_2) = \text{ewewigs } n(I_2) + \text{verandering in } n(I_2)$
- Substitute $254\text{ g}\cdot\text{mol}^{-1}$ as molar mass for I_2 . ✓
Vervang $254\text{ g}\cdot\text{mol}^{-1}$ as molêre massa van for I_2 .
- Final answer/Finale antwoord: 24,89 - 24,92 (g) ✓

OPTION 1/OPSIE 1

$$K_c = \frac{[HI]^2}{[H_2][I_2]} \checkmark$$

$$\therefore 55,3 \checkmark = \frac{[HI]^2}{(0,014)(0,0085)} \checkmark$$

$$\therefore [HI] = 0,08112 \text{ mol-dm}^{-3}$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{8}{9}$

Wrong K_c expression/Verkeerde K_c -uitdrukking: Max./Maks. $\frac{6}{9}$

	H ₂	I ₂	HI	
Initial mass (g) Aanvangsmassa (g)		(0,09812)(254) ✓ = 24,92 g ✓		
Initial quantity (mol) Aanvangshoeveelheid (mol)	0,1091	0,09812	0	
Change (mol) Verandering (mol)	0,08112	✓ 0,08112	0,1622 ✓	Using ratio ✓
Quantity at equilibrium (mol)/ Hoeveelheid by ewewig (mol)	0,028	0,017	0,1622	
Equilibrium concentration (mol-dm ⁻³) Ewewigskonsentrasie (mol-dm ⁻³)	0,014	0,0085	0,08112	x 2

Divide by 2 ✓

OR/OF

$$K_c = \frac{[HI]^2}{[H_2][I_2]} \checkmark$$

$$\therefore 55,3 \checkmark = \frac{x^2}{(0,014)(0,0085)} \checkmark$$

$$\therefore x = 0,08112 \text{ mol-dm}^{-3}$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{8}{9}$

Wrong K_c expression/Verkeerde K_c -uitdrukking: Max./Maks. $\frac{6}{9}$

	H ₂	I ₂	HI	
Initial mass (g) Aanvangsmassa (g)				
Initial quantity (mol) Aanvangshoeveelheid (mol)	x+0,028	x + 0,017	0	
Change (mol) Verandering (mol)	x	✓ x	2x ✓	Using ratio ✓
Quantity at equilibrium (mol)/ Hoeveelheid by ewewig (mol)	0,028	0,017	2x	
Equilibrium concentration (mol-dm ⁻³) Ewewigskonsentrasie (mol-dm ⁻³)	0,014	0,0085	x	x 2

Divide by 2 ✓

$$\text{Initial quantity } I_2(\text{mol})/\text{Aanvangshoeveelheid } I_2(\text{mol}) = 0,08112 + 0,017 = 0,09812 \text{ mol}$$

$$\begin{aligned} m(I_2) &= nM \\ &= (0,09812)(254) \checkmark \\ &= 24,92 \text{ g } \checkmark \end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{array}{lcl}
 c(\text{H}_2) = \frac{n}{V} & c(\text{I}_2) = \frac{n}{V} & \\
 = \frac{0,028}{2} & = \frac{0,017}{2} & \\
 = 0,014 \text{ mol} \cdot \text{dm}^{-3} & = 0,0085 \text{ mol} \cdot \text{dm}^{-3} & \left. \vphantom{\begin{array}{l} c(\text{H}_2) \\ c(\text{I}_2) \end{array}} \right\} \text{Divide by } 2 \text{ dm}^3 \checkmark
 \end{array}$$

$$K_c = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]} \checkmark$$

$$55,3 \checkmark = \frac{[\text{HI}]^2}{(0,014)(0,0085)} \checkmark$$

$$[\text{HI}] = 0,08112 \text{ mol} \cdot \text{dm}^{-3}$$

$$n(\text{HI at equilibrium/by ewewig}) = (0,08112)(2) = 0,1622 \text{ mol}$$

$$n(\text{HI formed/gevorm}) = n(\text{HI at equilibrium/by ewewig}) = 0,1622 \text{ mol} \checkmark$$

$$n(\text{I}_2 \text{ reacted/gerageer}) = \frac{1}{2}n(\text{HI formed/gevorm}) = 0,08112 \text{ mol} \checkmark$$

$$n(\text{I}_2 \text{ initial/ aanvanklik}) = n(\text{I}_2 \text{ reacted/gerageer}) + n(\text{I}_2 \text{ equilibrium/ewewig})$$

$$= 0,08112 + 0,017 \checkmark$$

$$= 0,09812 \text{ mol}$$

$$m(\text{I}_2 \text{ initial/aanvanklik}) = nM$$

$$= (0,09812)(254) \checkmark$$

$$= 24,92 \text{ (g)} \checkmark$$

CALCULATIONS USING CONCENTRATION**BEREKENINGE WAT KONSENTRASIE GEBRUIK****Mark allocation/Puntetoekenning:**

- Divide equilibrium moles of H_2 and I_2 by 2 dm^3 . $\checkmark$
Deel ewewigshoeveelhede van H_2 en I_2 deur 2 dm^3 .
- Correct K_c expression (formulae in square brackets). $\checkmark$
Korrekte K_c -uitdrukking (formules in vierkanthakies).
- Substitution of equilibrium concentrations into K_c expression. $\checkmark$
Vervanging van ewewigskonsentrasies in K_c -uitdrukking.
- Substitution of K_c value/Vervanging van K_c -waarde. $\checkmark$
- Change in $n(\text{HI}) = n(\text{HI at equilibrium})$. $\checkmark$
Verandering in $n(\text{HI}) = n(\text{HI by ewewig})$
- **USING** ratio/**GEBRUIK** verhouding: $\text{H}_2 : \text{I}_2 : \text{HI} = 1 : 1 : 2$ $\checkmark$
- Initial $[\text{I}_2] = \text{equilibrium } [\text{I}_2] + \text{change in } [\text{I}_2]$ $\checkmark$
Aanvanklike $n(\text{I}_2) = \text{ewewigs } n(\text{I}_2) + \text{verandering in } n(\text{I}_2)$
- Substitute $254 \text{ g} \cdot \text{mol}^{-1}$ as molar mass for I_2 . $\checkmark$
Vervang $254 \text{ g} \cdot \text{mol}^{-1}$ as molêre massa van for I_2 .
- Final answer/Finale antwoord: 24,89 – 24,92 (g) $\checkmark$

OPTION 3/OPSIE 3

$$K_c = \frac{[HI]^2}{[H_2][I_2]} \checkmark$$

$$55,3 \checkmark = \frac{[HI]^2}{(0,014)(0,0085)} \checkmark$$

$$[HI] = 0,08112 \text{ mol-dm}^{-3}$$

$$c = \frac{m}{MV}$$

$$0,04905 = \frac{m}{(254)(2)}$$

$$\therefore m = 24,89 \text{ g} \checkmark$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{8}{9}$

Wrong K_c expression/Verkeerde K_c -uitdrukking: Max./Maks. $\frac{6}{9}$

	H_2	I_2	HI
Initial concentration (mol-dm ⁻³) Aanvangskonsentrasie (mol-dm ⁻³)		0,04905	0
Change (mol-dm ⁻³) Verandering (mol-dm ⁻³)	0,04055	0,04055	0,08112
Equilibrium concentration (mol-dm ⁻³) Ewewigskonsentrasie (mol-dm ⁻³)	0,014	0,0085	0,08112

ratio $\checkmark$
verhouding

(9)

6.3 (Chemical/dynamic) equilibrium / (Chemiese/dinamiese) ewewig $\checkmark$

OR/OF

The rate of the forward reaction equals the rate of the reverse reaction.
Die tempo van die voorwaartse reaksie is gelyk aan die tempo van die terugwaartse reaksie.

(1)

6.4 Addition of a catalyst. / Byvoeging van 'n katalisator. $\checkmark$
Increase in pressure. / Toename in druk. $\checkmark$

(2)

6.5.1  Endothermic / Endotermies $\checkmark$

- The rate of the forward reaction decreases more. / The rate of the reverse reaction decreases less. $\checkmark$
Die tempo van die voorwaartse verminder meer. / Die tempo van die terugwaartse reaksie verminder minder.
- A decrease in temperature favours the exothermic reaction. $\checkmark$
'n Afname in temperatuur bevoordeel die eksotermiese reaksie.

(3)

6.5.2 Decreases / Verlaag $\checkmark$

(1)

6.6 Reactants / H_2 / I_2 removed $\checkmark$
Reaktanse / H_2 / I_2 verwyder

(1)

[18]

QUESTION/VRAAG 5

5.1

ANY ONE/ENIGE EEN:

- Change in concentration of products/reactants per (unit) time. ✓✓
Verandering in konsentrasie van produkte/reaktanse per (eenheid) tyd.
- Rate of change in concentration.
Tempo van verandering in konsentrasie.
- Change in amount/number of moles/volume/mass of products or reactants per (unit) time.
Verandering in hoeveelheid/getal mol/volume/massa van produkte of reaktanse per (eenheid) tyd.
- Amount/number of moles/volume/mass of products formed or reactants used per (unit) time.
Hoeveelheid/getal mol/volume/massa van produkte gevorm of reaktanse gebruik per (eenheid) tyd.

(2)

5.2

Marking criteria/Nasienriglyne:	
Dependent and independent variables correctly identified. <i>Afhanklike en onafhanklike veranderlikes korrek geïdentifiseer.</i>	✓
Ask a question about the relationship between the independent and dependent variables. <i>Vra 'n vraag oor die verwantskap tussen die afhanklike en onafhanklike veranderlikes.</i>	✓

Examples/Voorbeelde:

- What is the relationship between concentration and reaction rate?
Wat is die verwantskap tussen konsentrasie en reaksietempo?
- How does the reaction rate change when the concentration changes/increases/decreases?
Hoe sal die reaksietempo verander wanneer die konsentrasie verander/verhoog/verlaag?

(2)

5.3

Q ✓

- Smaller gradient./Less steep. ✓
Kleiner gradiënt./Minder steil.
- Reaction **I** has the lowest HCl concentration and will take longer to reach completion/for the maximum volume of gas to be formed. ✓
*Reaksie **I** het die laagste HCl-konsentrasie en neem langer om voltooi te word/die maksimum volume gas te vorm.*

(3)

5.4

OPTION 1/OPSIE 1 Ave rate/Gem. tempo = $\frac{\Delta V}{\Delta t}$ $15 = \frac{\Delta V}{30 - 0}$ ✓ $V(\text{H}_2)_{\text{produced/berei}} = 450 \text{ cm}^3$ $n(\text{H}_2)_{\text{produced/berei}} = \frac{V}{V_m}$ $= \frac{450}{24\,000}$ ✓ $= 0,0188 \text{ mol}$ $n(\text{Zn}) = n(\text{H}_2) = 0,0188 \text{ mol}$ ✓ $n(\text{Zn})_{\text{used/gebruik}} = \frac{m}{M}$ $\therefore 0,0188 = \frac{m}{65}$ ✓ $\therefore m(\text{Zn}) = 1,22 \text{ g}$ ✓	OPTION 2/OPSIE 2 Ave rate/Gem. tempo = $\frac{15}{24\,000}$ ✓ $= 6,25 \times 10^{-4} \text{ mol} \cdot \text{s}^{-1}$ $V(\text{H}_2)_{\text{produced/berei}} = 6,25 \times 30$ ✓ $= 0,0188 \text{ mol}$ $n(\text{Zn}) = n(\text{H}_2) = 0,0188 \text{ mol}$ ✓ $n(\text{Zn})_{\text{used}} = \frac{m}{M}$ $0,0188 = \frac{m}{65}$ ✓ $\therefore m(\text{Zn}) = 1,22 \text{ g}$ ✓ OPTION 3/OPSIE 3 Ave rate/Gem. tempo = $\frac{\Delta V}{\Delta t}$ $15 = \frac{\Delta V}{30 - 0}$ ✓ $V(\text{H}_2)_{\text{produced/berei}} = 450 \text{ cm}^3$ 65 g ✓ Zn 24 000 cm³ ✓ x g Zn 450 cm³ ✓ x = 1,22 g ✓
--	--

(5)

5.5

5.5.1 Equal to/Gelyk aan ✓

(1)

5.5.2 Equal to/Gelyk aan ✓

(1)

5.6

- At higher temperature the average kinetic energy of particles is higher. ✓
By hoër temperatuur is die gemiddelde kinetiese energie van deeltjies hoër.
- More molecules gain sufficient/enough kinetic energy **OR** more molecules have kinetic energy equal to or greater than the activation energy. ✓
*Meer molekule het voldoende/genoeg kinetiese energie **OF** meer molekule het kinetiese energie gelyk aan of groter as die aktiveringsenergie.*
- More effective collisions per unit time./Frequency of effective collisions increases. ✓
Meer effektiewe botsings per eenheidtyd./Frekwensie van effektiewe botsings neem toe.

(3)

[17]

QUESTION/VRAAG 6

- 6.1 The stage in a chemical reaction when the rate of forward reaction equals the rate of reverse reaction. ✓✓
Die stadium in 'n chemiese reaksie wanneer die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie.

OR/OF

The stage in a chemical reaction when the concentrations of reactants and products remain constant. ✓✓
Die stadium in 'n chemiese reaksie wanneer die konsentrasies van reaktanse en produkte konstant bly.

(2)

6.2

6.2.1

OPTION 1/OPSIE 1

$$n = \frac{m}{M}$$

$$= \frac{1,12}{28} \checkmark$$

$$= 0,04 \text{ mol}$$

	COBr ₂	CO	Br ₂
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>		0	0
Change (mol) <i>Verandering (mol)</i>	0,04	0,04	0,04
Quantity at equilibrium (mol)/ <i>Hoeveelheid by ewewig (mol)</i>		0,04	0,04 ✓
Equilibrium concentration/ <i>Ewewigskonsentrasie (mol·dm⁻³)</i>		0,02	0,02

Divide by 2 ✓
Deel deur 2

$$K_c = \frac{[\text{CO}][\text{Br}_2]}{[\text{COBr}_2]} \checkmark$$

$$0,19 \checkmark = \frac{(0,02)^2}{[\text{COBr}_2]} \checkmark$$

$$[\text{COBr}_2] = 2,11 \times 10^{-3} \text{ mol·dm}^{-3} \checkmark$$

OPTION 2/OPSIE 2

$$n = \frac{m}{M}$$

$$= \frac{1,2}{28} \checkmark$$

$$= 0,04 \text{ mol}$$

$$n(\text{CO})_{\text{formed/gevorm}} = n(\text{Br}_2)_{\text{formed/gevorm}} \checkmark$$

$$= 0,04 \text{ mol}$$

$$c(\text{CO})_{\text{eq/ewe}} = c(\text{Br}_2)_{\text{eq/ewe}}$$

$$= \frac{n}{V}$$

$$= \frac{0,04}{2} \checkmark$$

$$= 0,02 \text{ mol} \cdot \text{dm}^{-3}$$

$$K_c = \frac{[\text{CO}][\text{Br}_2]}{[\text{COBr}_2]} \checkmark$$

$$0,19 \checkmark = \frac{(0,2)^2}{[\text{COBr}_2]} \checkmark$$

$$[\text{COBr}_2] = 2,11 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3} \checkmark$$

(7)

6.2.2

OPTION 1/OPSIE 1

$$n(\text{COBr}_2)_{\text{eq/ewewig}} = cV$$

$$= 2,11 \times 10^{-3} \times 2 \checkmark$$

$$= 4,22 \times 10^{-3} \text{ mol}$$

$$n(\text{COBr}_2)_{\text{initial/begin}} \leftarrow$$

$$= 0,04 + 4,22 \times 10^{-3} \checkmark$$

$$= 0,044 \text{ mol}$$

$$\% \text{ decomposed} = \frac{0,04}{0,044} \times 100$$

$$= 90,46\% \checkmark$$

Range/Gebied: 90,46 – 90,9%

OPTION 2/OPSIE 2

$$n(\text{COBr}_2)_{\text{eq/ewewig}} = cV$$

$$= 2,11 \times 10^{-3} \times 2 \checkmark$$

$$= 4,22 \times 10^{-3} \text{ mol}$$

$$n(\text{COBr}_2)_{\text{initial/begin}} \leftarrow$$

$$= 0,04 + 4,22 \times 10^{-3} \checkmark$$

$$= 0,044 \text{ mol}$$

$$m(\text{COBr}_2)_{\text{initial/begin}} = nM$$

$$= 0,044 \times 188$$

$$= 8,27 \text{ g}$$

$$m(\text{COBr}_2)_{\text{reacted/reageer}} = 0,04 \times 188$$

$$= 7,52 \text{ g}$$

$$\% \text{ decomposed/ontbind} = \frac{7,52}{8,27} \times 100$$

$$= 90,9\% \checkmark$$

(4)

6.3 $K_c < 0,19$

(1)

6.4 Decreases/Verminder ✓

A decreases in pressure favours the reaction that produces the larger number of moles of gas. / n Afname in druk bevoordeel die reaksie wat die groter aantal mol gas lewer. ✓

The forward reaction will be favoured. / Die voorwaartse reaksie sal bevoordeel word. ✓

(3)

[17]

QUESTION 5/VRAAG 5

5.1 **ONLY ANY ONE OF/SLEGS ENIGE EEN VAN:**

- Change in concentration ✓ of a reactant/product per unit time. ✓
Verandering in konsentrasie van reaktanse/produkte per eenheidtyd.
- Rate of change in concentration. ✓✓
Tempo van verandering in konsentrasie.
- Change in amount/number of moles/volume/mass of products/reactants per (unit) time./Verandering in hoeveelheid/getal mol/volume/massa van produkte/reaktanse per (eenheid)tyd.
- Amount/number of moles/volume/mass of products formed OR reactants used per (unit) time./Hoeveelheid/getal mol/volume/massa van produkte gevorm OF reaktanse gebruik per (eenheid)tyd.

(2)

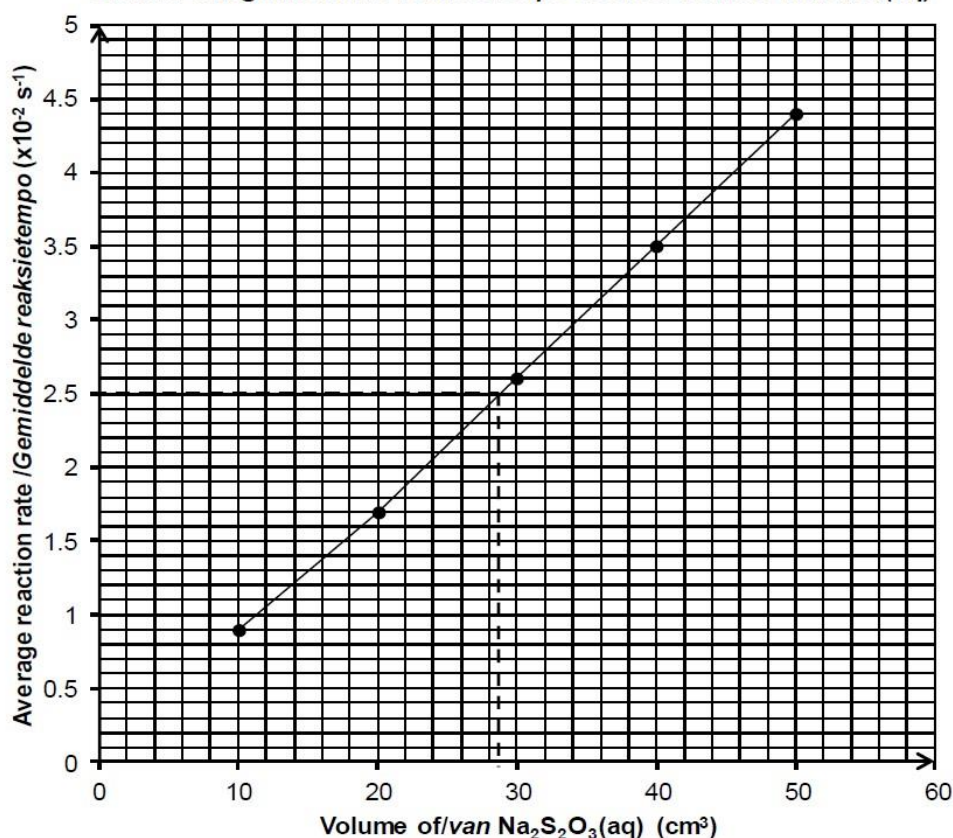
5.2 More than/Groter as ✓

Accept/Aanvaar

Equal to/Gelyk aan

(1)

5.3 **Graph of average reaction rate versus volume of $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$**
Grafiek van gemiddelde reaksietempo teenoor volume $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$



Marking criteria/Nasienriglyne:	
Any 3 points correctly plotted./Enige 3 punte korrek gestip.	✓
All (5) points correctly plotted./Alle (5) punte korrek gestip.	✓
Straight line drawn./Reguitlyn getrek.	✓

(3)

5.4

5.4.1

Marking criteria/Nasienriglyne:
y axis/y-as: $2,5 \times 10^{-2} \text{ s}^{-1}$ ✓
Dotted line drawn from the y-axis to the x-axis as shown. ✓ <i>Stippellyn getrek van y-as na x-as soos getoon.</i>
$V = 28 \text{ to } 30 \text{ cm}^3$ ✓

(3)

5.4.2

Criteria for conclusion/Riglyne vir gevolgtrekking:	
Dependent and independent variables correctly identified. <i>Afhanklike en onafhanklike veranderlikes korrek geïdentifiseer.</i>	✓
Relationship between the independent and dependent variables correctly stated. <i>Verwantskap tussen die afhanklike en onafhanklike veranderlikes korrek genoem.</i>	✓

Examples/Voorbeelde:

- Reaction rate of reaction increases with an increase in concentration/volume of sodium thiosulphate.
Reaksietyempo neem toe met 'n toename in konsentrasie/volume van natriumtiosulfaat.
- Reaction rate decreases with a decrease in concentration/volume of sodium thiosulphate.
Reaksietyempo neem af met 'n afname in konsentrasie/volume van natriumtiosulfaat.
- Reaction rate is (directly) proportional to concentration/volume of sodium thiosulphate.
Reaksietyempo is (direk) eweredig aan konsentrasie/volume van natriumtiosulfaat.

(2)

5.5

- More($\text{Na}_2\text{S}_2\text{O}_3$) particles per unit volume. ✓
Meer $\text{Na}_2\text{S}_2\text{O}_3$ -deeltjies per eenheid volume.
- More effective collisions per unit time./Higher frequency of effective collisions. ✓
Meer effektiewe botsings per eenheid tyd./Hoër frekwensie van effektiewe botsings.
- Increase in reaction rate./Toename in reaksietyempo. ✓

(3)

5.6

OPTION 1/OPSIE 1	Marking criteria/Nasienriglyne:
$n(\text{S})_{\text{produced/gevorm}} = \frac{m}{M}$ $= \frac{1,62}{32} \checkmark$ $= 0,0506 \text{ mol}$	- Substitute/Vervang 32 in $n = \frac{m}{M}$ ✓ - Use ratio/Gebruik verhouding: $\text{Na}_2\text{S}_2\text{O}_3$: S = 1 : 1 ✓ - Substitute/Vervang 158 in $n = \frac{m}{M}$ ✓ - Final answer/Finale antwoord: 7,90 to/tot 8,06 g ✓
$n(\text{Na}_2\text{S}_2\text{O}_3) = n(\text{S}) = 0,0506 \text{ mol} \checkmark$	
$n(\text{Na}_2\text{S}_2\text{O}_3) = \frac{m}{M}$ $0,0506 = \frac{m}{158} \checkmark$ $\therefore m(\text{Na}_2\text{S}_2\text{O}_3) = 7,99 \text{ g} \checkmark$	
[Range/Gebied: 7,90 to 8,06]	OPTION 2/OPSIE 2 $158 \text{ g} \checkmark \text{Na}_2\text{S}_2\text{O}_3 \longrightarrow 32 \text{ g} \checkmark \text{S}$ $\therefore x \longrightarrow 1,62 \text{ g S} \checkmark$ $x = \frac{158 \times 1,62}{32} = 7,99 \text{ g} \checkmark$
	[Range/Gebied: 7,90 to 8,06]

(4)

[18]

QUESTION 6/VRAAG 6

6.1

- 6.1.1 When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will oppose the disturbance. ✓✓
Wanneer die ewewig in 'n geslote sisteem versteur word, stel die sisteem 'n nuwe ewewig in deur die reaksie wat die versteuring teenwerk, te bevoordeel. (2)

- 6.1.2
- Percentage yield increases with an increase in temperature. ✓
Persentasie opbrengs verhoog met toename in temperatuur.
 - Forward reaction is favoured. ✓
Voorwaartse reaksie word bevoordeel.
 - Increase in temperature favours an endothermic reaction. ✓
Toename in temperatuur bevoordeel die endotermiese reaksie. (3)

- 6.1.3 When the pressure increases, the reaction that leads to a decrease in the number of moles will be favoured. ✓✓
Wanneer die druk verhoog, word die reaksie wat tot 'n afname in die aantal mol lei, bevoordeel.
Accept/Aanvaar
 When the pressure increases, the yield increases ✓ because the equilibrium position shifts to the right. ✓
Wanneer die druk toeneem, neem die opbrengs toe omdat die ewewigsposisie na regs skuif. (2)

- 6.1.4 I ✓✓ (2)

6.2

Mark allocation/Puntetoekenning

- Substitution of/Vervanging van $36,5 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$. ✓
- Change/Verandering $n(\text{HCl}) = \text{initial/aanvanklik} - \text{equilibrium/ewewig}$. ✓
- USING ratio/GEBRUIK verhouding: $4 : 1 : 2 : 2$ ✓
- Equilibrium: $n(\text{O}_2)$ & $n(\text{H}_2\text{O})$ & $n(\text{Cl}_2) = \text{initial} \pm \text{change}$ ✓
Ewewig: : $n(\text{O}_2)$ & $n(\text{H}_2\text{O})$ & $n(\text{Cl}_2) = \text{aanvanklik} \pm \text{verandering}$
- Divide by volume/Gedeel deur volume ($0,2 \text{ dm}^3$) ✓
- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c -uitdrukking (formules tussen vierkanthakies).
- Substitution of reactant concentrations/Vervanging van reaktanskonsentrasies. ✓
- Substitution of product concentrations./Vervanging van produk-konsentrasies. ✓
- Final answer/Finale antwoord: 13,966 to/tot 18,72 ✓
Range/Gebied: 13,966 to/tot 18,72

OPTION 1/OPSIE 1

	HCl	O ₂	Cl ₂	H ₂ O	
Initial quantity/Aanvangshoeveelheid (mol)	0,2	0,11	0	0	
Change/Verandering (mol)	0,15 ✓	0,0375	0,075	0,075	ratio ✓ verhouding
Quantity at equilibrium/Hoeveelheid by ewewig (mol)	$\frac{1,825}{36,5} = 0,05$ ✓	0,0725	0,075	0,075	✓
Equilibrium concentration/Ewewigskonsentrasie (mol·dm ⁻³)	0,25	0,3625	0,375	0,375	Divide by 0,2 ✓ Deel deur 0,2

$$K_c = \frac{[Cl_2]^2[H_2O]^2}{[HCl]^4[O_2]} = \frac{(0,375)^2(0,375)^2}{(0,25)^4(0,3625)} = 13,97 \checkmark$$

No K_c expression, correct substitution/Geen K_c-uitdrukking, korrekte vervanging:

Max./Maks. $\frac{8}{9}$

Wrong K_c expression/Verkeerde K_c-uitdrukking: Max./Maks. $\frac{5}{9}$

(9)

OPTION 2/OPSIE 2:

$$n(HCl)_{\text{equilibrium/ewewig}} = \frac{m}{M} = \frac{1,825}{36,5} = 0,05 \text{ mol}$$

$$n(HCl)_{\text{reacted/reageer}} = 0,2 - 0,05 = 0,15 \text{ mol} \checkmark$$

$$\left. \begin{aligned} n(O_2)_{\text{reacted/reageer}} &= \frac{1}{4}n(HCl)_{\text{reacted/reageer}} = \frac{1}{4} \times 0,15 = 0,0375 \text{ mol} \\ n(Cl_2)_{\text{formed/gevorm}} &= \frac{1}{2}n(HCl)_{\text{reacted/reageer}} = \frac{1}{2} \times 0,15 = 0,075 \text{ mol} \\ n(H_2O)_{\text{formed/gevorm}} &= \frac{1}{2}n(HCl)_{\text{reacted/reageer}} = \frac{1}{2} \times 0,15 = 0,075 \text{ mol} \end{aligned} \right\} \text{Using ratio } \checkmark$$

$$\left. \begin{aligned} n(O_2)_{\text{equilibrium/ewewig}} &= 0,11 - 0,0375 = 0,0725 \text{ mol} \\ n(Cl_2)_{\text{equilibrium/ewewig}} &= n(H_2O)_{\text{equilibrium/ewewig}} = 0,075 \text{ mol} \end{aligned} \right\} \checkmark$$

$$c(O_2)_{\text{equilibrium/ewewig}} = \frac{n}{V} = \frac{0,0375}{0,2} = 0,3625 \text{ mol} \cdot \text{dm}^{-3}$$

$$\left. \begin{aligned} c(Cl_2)_{\text{equilibrium/ewewig}} &= c(H_2O)_{\text{equilibrium/ewewig}} = \frac{n}{V} \\ &= \frac{0,075}{0,2} = 0,375 \text{ mol} \cdot \text{dm}^{-3} \end{aligned} \right\} \text{Divide by/} \\ \text{deel deur } 0,2 \checkmark$$

$$K_c = \frac{[H_2O]^2[Cl_2]^2}{[HCl]^4[O_2]} = \frac{(0,375)^2(0,375)^2}{(0,25)^4(0,3625)} = 13,97 \checkmark$$

No K_c expression, correct substitution/Geen K_c-uitdrukking, korrekte substitusie:

Max./Maks. $\frac{8}{9}$

Wrong K_c expression/Verkeerde K_c-uitdrukking:

Max./Maks. $\frac{5}{9}$

(9)

CALCULATIONS USING CONCENTRATIONS
BEREKENINGE WAT KONSENTRASIES GEBRUIK

Mark allocation/Puntetoekenning

- Substitution of/Vervanging van $36,5 \text{ g} \cdot \text{mol}^{-1} n = \frac{m}{M}$. ✓
- Initial concentration of reactants/Aanvanklike konsentrasie van reaktanse:
 $c(\text{HCl}) = 1,0$ & $c(\text{O}_2) = 0,55 \text{ mol} \cdot \text{dm}^{-3}$ ✓
- Change: $c(\text{HCl}) = 0,75 \text{ mol} \cdot \text{dm}^{-3}$ (initial – equilibrium) ✓
Verandering: $c(\text{HCl}) = 0,75 \text{ mol} \cdot \text{dm}^{-3}$ (aanvanklik – ewewig)
- USING ratio/GEBRUIK verhouding: 4 : 1 : 2 : 2 ✓
- Equilibrium/Ewewig: $c(\text{H}_2\text{O}) = c(\text{Cl}_2) = 0,3625 \text{ mol} \cdot \text{dm}^{-3}$ (initial+change) and $c(\text{O}_2) = 0,3625 \text{ mol} \cdot \text{dm}^{-3}$ (initial – change) ✓
Ewewig: $c(\text{H}_2\text{O}) = c(\text{Cl}_2) = 0,3625 \text{ mol} \cdot \text{dm}^{-3}$ (aanvanklik + verandering) en $c(\text{O}_2) = 0,0,3625 \text{ mol} \cdot \text{dm}^{-3}$ (aanvanklik – verandering)
- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c -uitdrukking (formules tussen vierkanthakies).
- Substitution of reactant concentrations./Vervanging van reaktanskonsentrasies. ✓
- Substitution of product concentrations./Vervanging van produkkonsentrasies. ✓
- Final answer/Finale antwoord: 13,97 ✓
 Range/Gebied: 13,966 to/tot 18,72

OPTION 3/OPSIE 3

$$n(\text{HCl})_{\text{equilibrium/ewewig}} = \frac{m}{M}$$

$$= \frac{1,825}{36,5} \checkmark$$

$$= 0,05 \text{ mol}$$

	HCl	O ₂	H ₂ O	Cl ₂	
Initial concentration/ Aanvangskonsentrasie (mol·dm ⁻³)	1,0 ✓	0,55	0	0	Divide by 0,2 ✓ Deel deur 0,2
Change in concentration Verandering in konsentrasie (mol·dm ⁻³)	0,75 ✓	0,1875	0,375	0,375	ratio ✓ verhouding
Equilibrium concentration Ewewigskonsentrasie (mol·dm ⁻³)	0,25	0,3625	0,375	0,375	✓

$$K_c = \frac{[\text{Cl}_2]^2 [\text{H}_2\text{O}]^2}{[\text{HCl}]^4 [\text{O}_2]} \checkmark = \frac{(0,375)^2 (0,375)^2}{(0,25)^4 (0,3625)} \checkmark = 13,97 \checkmark$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie:

Max./Maks. $\frac{8}{9}$

Wrong K_c expression/Verkeerde K_c -uitdrukking:

Max./Maks. $\frac{5}{9}$

(9)
[18]

QUESTION 5/VRAAG 5

5.1 Temperature/Temperatuur 

(1)

5.2

NOTE/LET WEL

Give the mark for per unit time only if in context of reaction rate.

Gee die punt vir per eenheidtyd slegs indien in konteks met reaksietempo.

ANY ONE/ENIGE EEN

- Change in concentration  of products/reactants per (unit) time. 
Verandering in konsentrasie van produkte/reaktanse per (eenheid) tyd.
- Change in amount/number of moles/volume/mass of products or reactants per (unit) time.
Verandering in hoeveelheid/getal mol/volume/massa van produkte of reaktanse per (eenheid) tyd.
- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time.
Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktanse gebruik per (eenheid) tyd.
- Rate of change in concentration/amount/number of moles/volume/mass.
Tempo van verandering in konsentrasie/ hoeveelheid/getal mol/ volume/massa.   (2 or/of 0)

(2)

5.3 14 (min)  

(2)

5.4

5.4.1 Graph/grafiek B

(Experiment 3) has the highest (acid) concentration/more particles/higher number of moles.
(Eksperiment 3) het die hoogste (suur)konsentrasie/meer deeltjies/groter aantal mol.

(2)

5.4.2 (Graph/grafiek) C

(Experiment 5) is at highest temperature/more particles with sufficient kinetic energy/HCl is at 35°C
(Eksperiment 5) is by die hoogste temperatuur/meer deeltjies met genoeg kinetiese energie/HCl is by 35°C.

(2)

5.5

5.5.1 Speeds up the reaction./Increases the reaction rate./Provides alternate pathway./Lowers the (net) activation energy.
Versnel die reaksie./Verhoog die reaksietempo./Verskaf alternatiewe roete./Verlaag die (netto) aktiveringsenergie.

(1)

5.5.2 Equal to/Gelyk aan

(1)

5.6

$$\begin{aligned} n(\text{Zn}) &= \frac{m}{M} \\ &= \frac{1,5}{65} \\ &= 0,023 \text{ mol} \\ \text{rate/tempo} &= -\frac{\Delta n}{\Delta t} \\ &= -\left(\frac{0 - 0,023}{14,50}\right) \\ &= 1,65 \times 10^{-3} \text{ (mol} \cdot \text{min}^{-1}) \end{aligned}$$

Marking guidelines/Nasienriglyne

- Substitute/vervang 65 g·mol⁻¹ in

$$n = \frac{m}{M}$$

- Substitute change in mol to calculate rate./Vervang verandering in mol om tempo te bereken.
- Substitute change in time to calculate rate./Vervang verandering in tyd om tempo te bereken.
- Final answer/Finale antwoord:

$$1,65 \times 10^{-3} \text{ mol} \cdot \text{min}^{-1}$$

Range/Gebied:

$$1,43 \times 10^{-3} \text{ to/tot } 1,65 \times 10^{-3} \text{ (mol} \cdot \text{min}^{-1})$$

Notes/Aantekeninge

- Ignore if zeros omitted in calculation of reaction rate./Ignoreer indien nulle uitgelaat in berekening van reaksietempo.
- Accept negative answer i.e. -1,65 x 10⁻³ mol·min⁻¹/Aanvaar negatiewe antwoord d.i. -1,65 x 10⁻³ mol·min⁻¹.

(4)

[15]

QUESTION 6/VRAAG 6

- 6.1 When the equilibrium in a closed system is disturbed, the system will re-instate a (new) equilibrium by favouring the reaction that will cancel/oppose the disturbance.
Wanneer die ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n (nuwe) ewewig instel deur die reaksie te bevoordeel wat die versteuring kanselleer/teenwerk. (2)
- 6.2 Endothermic/Endotermies
- Decrease in temperature favours the exothermic reaction.
Afname in temperatuur bevoordeel die eksotermiese reaksie.
 - The reverse reaction is favoured./Die terugwaartse reaksie word bevoordeel.
- OR/OF**
Number of moles/amount/concentration of N_2O_4 /colourless gas increases.
Aantal mol/hoeveelheid/konsentrasie van N_2O_4 /kleurlose gas neem toe.
- OR/OF**
Number of moles/amount of NO_2 /brown gas decreases./Aantal mol/hoeveelheid NO_2 /bruin gas neem af. (3)
- 6.3
- 6.3.1 Increases/Verhoog (1)
- 6.3.2 Remains the same/Bly dieselfde (1)
- 6.3.3 Increases/Verhoog (1)

CALCULATIONS USING NUMBER OF MOLES **BEREKENINGE WAT GETAL MOL GEBRUIK**

Marking guidelines/Nasienriglyne

- $\Delta n(\text{N}_2\text{O}_4) = 20\%$ of/van $x/0,2x$.
- **USE** ratio/**GEBRUIK** verhouding: $\text{N}_2\text{O}_4 : \text{NO}_2 = 1 : 2$.
- $n(\text{N}_2\text{O}_4)_{\text{eq/ewe}} = n(\text{N}_2\text{O}_4)_{\text{initial/begin}} - \Delta n(\text{N}_2\text{O}_4)$.
 $n(\text{NO}_2)_{\text{eq/ewe}} = n(\text{NO}_2)_{\text{initial/begin}} + \Delta n(\text{NO}_2)$.
- Divide equilibrium moles by 2 dm^3 /Deel ewewigsmol deur 2 dm^3 .
- Correct K_c expression (formulae in square brackets).
 Korrekte K_c uitdrukking (formules in vierkanthakies).
- Substitution of K_c value/Vervanging van K_c -waarde.
- Substitution of concentrations into correct K_c expression.
 Vervanging van konsentrasies in korrekte K_c -uitdrukking.
- Final answer/Finale antwoord: $1,6 \text{ (mol)}$

OPTION 1/OPSIE 1

	N_2O_4	NO_2	
Initial amount (moles) Aanvangshoeveelheid (mol)	x	0	
Change in amount (moles) Verandering in hoeveelheid (mol)	$0,2x$ ✓	$0,4x$	ratio ✓ verhouding
Equilibrium amount (moles) hoeveelheid (mol)	$0,8x$	$0,4x$	
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$) Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	$0,4x$	$0,2x$	Divide by 2 dm^3 ✓

$$K_c = \frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]}$$

$$0,16 \frac{(0,2x)^2}{(0,4x)}$$

$$x = 1,6 \text{ (mol)}$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/Verkeerde K_c -uitdrukking:
Max./Maks. $\frac{5}{8}$

OPTION 2/OPSIE 2

$$\Delta n(\text{N}_2\text{O}_4) = \frac{20}{100} x = 0,2x$$

$$\Delta n(\text{NO}_2) = 2\Delta n(\text{N}_2\text{O}_4) = 0,4x$$

$$n(\text{N}_2\text{O}_4)_{\text{eq/ewe}} = x - 0,2x = 0,8x \text{ AND } n(\text{NO}_2)_{\text{eq/ewe}} = 0 + 0,4x$$

$$c(\text{N}_2\text{O}_4)_{\text{eq/ewe}} = \frac{0,8x}{2} = 0,4x$$

$$c(\text{NO}_2)_{\text{eq/ewe}} = \frac{0,4x}{2} = 0,2x$$

$$K_c = \frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]}$$

$$0,16 \frac{(0,2x)^2}{(0,4x)}$$

$$x = 1,6 \text{ (mol)}$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/Verkeerde K_c -uitdrukking:
Max./Maks. $\frac{5}{8}$

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Marking guidelines/Nasiënriglyne

- Initial $n(\text{N}_2\text{O}_4)/x$ divide by 2 dm^3 .
- Aanvanklike $n(\text{N}_2\text{O}_4)/x$ gedeel deur 2 dm^3 .*
- $\Delta c(\text{N}_2\text{O}_4) = 20\%$ of initial concentration/ $0,1x$.
- USE** ratio/**GEBRUIK** verhouding: $c(\text{N}_2\text{O}_4) : c(\text{NO}_2) = 1 : 2$.
- $c(\text{N}_2\text{O}_4)_{\text{eq/ewe}} = c(\text{N}_2\text{O}_4)_{\text{initial/begin}} - \Delta c(\text{N}_2\text{O}_4)$.
 $c(\text{NO}_2)_{\text{eq/ewe}} = c(\text{NO}_2)_{\text{initial/begin}} + \Delta c(\text{NO}_2)$.
- Correct K_c expression (formulae in square brackets).
- Korrekte K_c uitdrukking (formules in vierkanthakies).*
- Substitution of K_c value/Vervanging van K_c -waarde.
- Substitution of concentrations into K_c expression.
- Vervanging van konsentrasies in K_c -uitdrukking.*
- Final answer/Finale antwoord: $1,6 \text{ (mol)}$

OPTION 3/OPSIE 3

	N_2O_4	NO_2	
Initial concentration ($\text{mol} \cdot \text{dm}^{-3}$) <i>Aanvanklike konsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)</i>	$\frac{x}{2} = 0,5x$	0	Divide by 2 dm^3 ✓
Change ($\text{mol} \cdot \text{dm}^{-3}$) <i>Verandering ($\text{mol} \cdot \text{dm}^{-3}$)</i>	$0,1x$	$0,2x$	ratio verhouding
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$) <i>Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)</i>	$0,4x$	$0,2x$	

$$K_c = \frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]}$$

$$0,16 \text{ } = \frac{(0,2x)^2}{0,4x} \text{$$

$$x = 1,6 \text{ (mol)} \text{$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{6}{8}$

Wrong K_c expression/Verkeerde K_c -uitdrukking:
Max./Maks. $\frac{5}{8}$

(8)
[16]

QUESTION 5/VRAAG 5

5.1 Exothermic/Eksotermies ✓


 $\Delta H < 0$ /Energy is released/Energie word vrygestel ✓

(2)

5.2

$\text{rate/tempo} = -\frac{\Delta m}{\Delta t}$ $= -\frac{0,25 - 2}{30} \checkmark$ $= 0,06 \text{ (g} \cdot \text{s}^{-1}) \checkmark$ $(0,0583 \text{ g} \cdot \text{s}^{-1})$	OR/OF $\text{rate/tempo} = -\frac{\Delta m}{\Delta t}$ $= -\frac{1,75}{30} \checkmark$ $= 0,06 \text{ (g} \cdot \text{s}^{-1}) \checkmark$ $(0,0583 \text{ g} \cdot \text{s}^{-1})$
Notes/Aantekeninge Accept negative answer i.e./Aanvaar negatiewe antwoord d.i. - 0,06 g·s ⁻¹ .	

(3)

5.3

Marking guidelines - Calculate/Bereken: $m(\text{CaCO}_3)$ reacted/reageer or / of $V(\text{CO}_2)$ produced/gevorm. ✓ - Substitute/Vervang: $100 \text{ g} \cdot \text{mol}^{-1}$. ✓ - USE mol ratio/GEBRUIK molverhouding: $n(\text{CO}_2) : n(\text{CaCO}_3) = 1 : 1$ ✓ - Use of / Gebruik van $22,4 \text{ dm}^3 \cdot \text{mol}^{-1}$. ✓ - Final answer/Finale antwoord: $0,18 \text{ dm}^3$ ($0,1792 \text{ dm}^3$) ✓	
OPTION 1/OPSIE 1 $m(\text{CaCO}_3) = \frac{40}{100} \times 2 \checkmark$ $= 0,8 \text{ g}$ $n(\text{CaCO}_3)_{\text{reacted}} = \frac{m}{M}$ $= \frac{0,8}{100} \checkmark$ $= 8 \times 10^{-3} \text{ mol}$ $n(\text{CO}_2) = n(\text{CaCO}_3) \checkmark$ $= 8 \times 10^{-3} \text{ mol}$ $V(\text{CO}_2) = 8 \times 10^{-3} \times 22,4 \checkmark$ $= 0,18 \text{ dm}^3 \checkmark$	OPTION 2/OPSIE 2 For 2 g antacid/teensuurtablet: $100 \text{ g} \checkmark \text{CaCO}_3 \dots\dots 22,4 \text{ dm}^3 \checkmark \text{CO}_2$ $2 \text{ g CaCO}_3 \dots\dots 0,448 \text{ dm}^3 \checkmark$ $100\% \text{ CO}_2 \dots\dots 0,448 \text{ dm}^3 \checkmark$ $40\% \text{ CO}_2 \dots\dots 0,18 \text{ dm}^3 \checkmark$ OPTION 3/OPSIE 3 $100\% \text{ CaCO}_3 \dots\dots 2 \text{ g}$ $40\% \dots\dots 0,8 \text{ g} \checkmark$ $100 \text{ g} \checkmark \dots\dots 1 \text{ mol}$ $0,8 \text{ g} \dots\dots 8 \times 10^{-3} \text{ mol} \checkmark$ $1 \text{ mol} \dots\dots 22,4 \text{ dm}^3 \checkmark$ $8 \times 10^{-3} \text{ mol} \dots\dots 0,18 \text{ dm}^3 \checkmark$

(5)

5.4

ANY ONE/ENIGE EEN:

- Concentration (of acid)/Konsentrasie (van suur) ✓
- Size/mass of tablet/Identical tablet /Type of tablet.
Grootte/massa van tablet/Identiese tablet./Tipe tablet.
- State of division / Surface area / Toestand van verdeeldheid / reaksieoppervlak.

(1)

5.5

Criteria for conclusion/Riglyne vir gevolgtrekking:	
Dependent [(reaction) rate/time] and independent (temperature) variables correctly identified. Afhanklike [(reaksie)tempo/tyd] en onafhanklike (temperatuur) veranderlikes korrek geïdentifiseer.	✓
Relationship between the independent and dependent variables correctly stated./Verwantskap tussen die afhanklike en onafhanklike veranderlikes korrek genoem.	✓

Examples/Voorbeelde:

- Reaction rate ($\frac{1}{\text{time}}$) increases with increase in temperature.
Reaksiestempo ($\frac{1}{\text{time}}$) neem toe met toename in temperatuur.
- Reaction rate ($\frac{1}{\text{time}}$) decreases with decrease in temperature.
Reaksiestempo ($\frac{1}{\text{time}}$) neem af met afname in temperatuur.
- Time taken for reaction decreases when temperature increases.
Tyd vir die reaksie neem af wanneer temperatuur toeneem.
- Time taken for reaction increases when temperature decreases.
Tyd vir die reaksie neem toe as temperatuur afneem.

IF/INDIEN

Reaction rate is DIRECTLY proportional to temperature: Max. $\frac{1}{2}$

Reaksiestempo is DIREK eweredig aan temperatuur: Maks. $\frac{1}{2}$

(2)

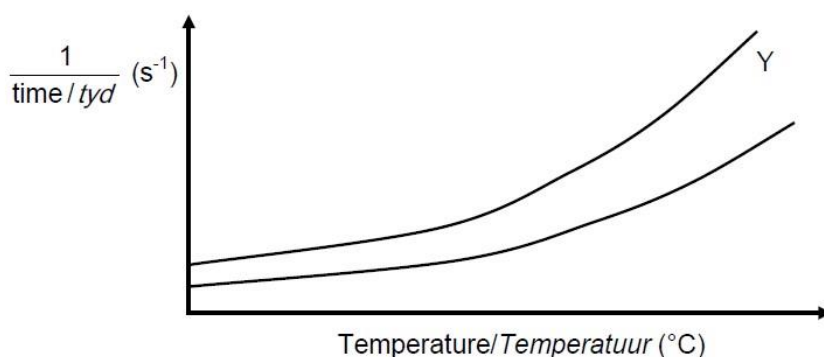
- 5.6
- Increase in temperature increases the average kinetic energy/molecules move faster. /*Toename in temperatuur verhoog die gemiddelde kinetiese energie/molekule beweeg vinniger.* ✓
 - More molecules have enough/sufficient kinetic energy/More molecules have $E_k > E_a$. ✓
Meer molekule het genoeg/voldoende kinetiese energie/Meer molekule het $E_k > E_a$.
 - More effective collisions per unit time/second. /Frequency of effective collisions increases. ✓
Meer effektiewe botsings per eenheidtyd/sekonde./Frekwensie van effektiewe botsings neem toe.

(3)

5.7

Marking guidelines/Nasienriglyne

- For each value of temperature, the CURVE Y must be above the given CURVE. /
Vir elke waarde van temperatuur, moet kurwe Y bo die gegewe kurwe wees. ✓
- CURVE Y must have an increasing rate with an increase in temperature. /
KURWE Y moet 'n toenemende tempo het soos die temperatuur toeneem. ✓



(2)

[18]

QUESTION 6/VRAAG 6

- 6.1 (The stage in a chemical reaction when the) rate of forward reaction equals the rate of reverse reaction. ✓✓
 (Die stadium in 'n chemiese reaksie wanneer die) tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. (2 or/of 0)

OR/OF

- (The stage in a chemical reaction when the) concentrations of reactants and products remain constant.
 (Die stadium in 'n chemiese reaksie wanneer die) konsentrasies van reaktanse en produkte konstant bly. (2 or/of 0) (2)

6.2 CALCULATIONS USING NUMBER OF MOLES BEREKENINGE WAT AANTAL MOL GEBRUIK

6.2.1 Marking guidelines/Nasiënriglyne

- Substitute/Vervang: $44 \text{ g} \cdot \text{mol}^{-1}$. ✓
- Equilibrium concentration of CO_2 multiply by 3 dm^3
Ewewigskonsentrasie van CO_2 vermenigvuldig met 3 dm^3 } ✓
AND/EN $n(\text{CO})_{\text{eq}}$ divide by /deel deur 3 dm^3
- Use mole ratio/Gebruik molverhouding: $1:2$ / $n(\text{CO}) = 2n(\text{CO}_2)$. ✓
- $n(\text{CO}_2)_{\text{change}} = n(\text{CO}_2)_{\text{initial}} - n(\text{CO}_2)_{\text{final}}$ } ✓
 $n(\text{CO})_{\text{eq/ewe}} = n(\text{CO})_{\text{initial/begin}} + \Delta n(\text{CO})$
- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c -uitdrukking (formules in vierkanthakies).
- Substitution of concentrations into K_c expression. ✓
Vervanging van konsentrasies in K_c -uitdrukking.
- Final answer/Finale antwoord: 12,24 (range/gebied: 11,85 – 12,66) ✓

OPTION 1/OPSIE 1

$$n(\text{CO}_2) = \frac{m}{M}$$

$$= \frac{60,8}{44} \checkmark$$

$$= 1,382 \text{ mol}$$

	CO ₂	CO
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	1,382	0
Change (mol) <i>Verandering (mol)</i>	✓ 1,22	2,44
Quantity at equilibrium (mol)/ <i>Hoeveelheid by ewewig (mol)</i>	0,162	2,44
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	0,054	0,813

Use ratio/*Gebruik verhouding* ✓

Divide/multiply by 3/*Deel/ vermenigvuldig met 3* ✓

$$K_c = \frac{[\text{CO}]^2}{[\text{CO}_2]} \checkmark$$

$$= \frac{(0,813)^2}{0,054} \checkmark$$

$$= 12,24 \checkmark$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./Maks. $\frac{6}{7}$

Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./Maks. $\frac{4}{7}$

OPTION 2/OPSIE 2

$$n(\text{CO}_2) = \frac{m}{M}$$

$$= \frac{60,8}{44} \checkmark$$

$$= 1,382 \text{ mol}$$

$$n(\text{CO}_2)_{\text{change}} = n(\text{CO}_2)_{\text{initial/begin}} - n(\text{CO}_2)_{\text{final/finaal}}$$

$$= 1,382 - 0,162$$

$$= 1,22 \text{ mol}$$

$$n(\text{CO})_{\text{change}} = 2(\text{CO}_2) \checkmark$$

$$= 2(1,22) \checkmark$$

$$= 2,44 \text{ mol}$$

$$n(\text{CO})_{\text{eq}} = n(\text{CO})_{\text{change}} = 2,44 \text{ mol}$$

$$c(\text{CO}) = \frac{n}{V}$$

$$= \frac{2,44}{3} \checkmark$$

$$= 0,813 \text{ mol·dm}^{-3}$$

$$K_c = \frac{[\text{CO}]^2}{[\text{CO}_2]} \checkmark$$

$$= \frac{(0,813)^2}{0,054} \checkmark$$

$$= 12,24 \checkmark$$

(Accept range/*Aanvaar gebied*: 11,85 – 12,66).

CALCULATIONS USING CONCENTRATION BEREKENINGE WAT KONSENTRASIE GEBRUIK

Marking guidelines/Nasienriglyne

- Substitute $44 \text{ g}\cdot\text{mol}^{-1}$. ✓
- Initial $n(\text{CO}_2)$ divide by 3 dm^3 . ✓
Aanvanklike $n(\text{CO}_2)$ gedeel deur 3 dm^3 .
- **USE** ratio/**GEBRUIK** verhouding: $c(\text{CO}_2) : c(\text{CO}) = 1 : 2$ ✓
- $\Delta c(\text{CO}_2) = c(\text{CO}_2)_{\text{initial/begin}} - c(\text{CO}_2)_{\text{eq/ewe}}$. ✓
 $c(\text{CO})_{\text{eq/ewe}} = c(\text{CO})_{\text{initial/begin}} + \Delta c(\text{CO})$. ✓
- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c uitdrukking (formules in vierkanthakies).
- Substitution of concentrations into K_c expression. ✓
Vervanging van konsentrasies in K_c -uitdrukking.
- Final answer/*Finale antwoord*: 12,15 (range/gebied: 11,85 – 12,66) ✓

OPTION 3/OPSIE 3

$$n(\text{CO}_2) = \frac{m}{M}$$

$$= \frac{60,8}{44} \checkmark$$

$$= 1,382 \text{ mol}$$

	CO_2	CO
Initial concentration ($\text{mol}\cdot\text{dm}^{-3}$) <i>Aanvanklike konsentrasie ($\text{mol}\cdot\text{dm}^{-3}$)</i>	0,4607	0
Change ($\text{mol}\cdot\text{dm}^{-3}$) <i>Verandering ($\text{mol}\cdot\text{dm}^{-3}$)</i>	0,4067	0,813
Equilibrium concentration ($\text{mol}\cdot\text{dm}^{-3}$) <i>Ewewigskonsentrasie ($\text{mol}\cdot\text{dm}^{-3}$)</i>	0,054	0,813

Divide by /Deel deur 3 dm^3 ✓
ratio ✓
verhouding

$$K_c = \frac{[\text{CO}]^2}{[\text{CO}_2]} \checkmark$$

$$= \frac{(0,813)^2}{0,054} \checkmark$$

$$= 12,15 \checkmark$$

No K_c expression, correct substitution/*Geen K_c -uitdrukking, korrekte substitusie*: Max./Maks. $\frac{6}{7}$
Wrong K_c expression/*Verkeerde K_c -uitdrukking*: Max./Maks. $\frac{4}{7}$

(7)

6.2.2 POSITIVE MARKING FROM Q6.2.1/POSITIEWE NASIEN VANAF V6.2.1

$$n(\text{C})_{\text{reacted/reageer}} =$$

$$n(\text{CO}_2)_{\text{reacted/reageer}} = 1,22 \text{ mol} \checkmark$$

$$m(\text{C}) = nM \checkmark$$

$$= 1,22(12) \checkmark$$

$$= 14,64 \text{ g} \checkmark$$

Marking guidelines

- **USE** mol ratio/ **GEBRUIK** molverhouding:
 $n(\text{C}) = n(\text{CO}_2)$. ✓
- Substitute/Vervang: $12 \text{ g}\cdot\text{mol}^{-1}$. ✓
- Final answer/*Finale antwoord*: 14,64 g. ✓

(3)

6.3

6.3.1 Remains the same/Bly dieselfde ✓

(1)

6.3.2 Decreases/Afneem ✓



- (When pressure is increased) the reaction that leads to the smaller amount/number of moles/volume of gas is favoured. ✓
(Wanneer die druk verhoog word,) word die reaksie wat tot die kleiner hoeveelheid/aantal mol/volume gas lei, bevoordeel.
- The reverse reaction is favoured. / More CO₂ is formed. ✓
Die terugwaartse reaksie word bevoordeel./ meer CO₂ word gevorm.

(3)

6.4

6.4.1 Endothermic/Endotermies ✓



- When the temperature increases the mol/percentage CO(g)/product increases/forward reaction is favoured./Wanneer die temperatuur toeneem, neem die mol/persentasie CO(g)/produk toe/voorwaartse reaksie word bevoordeel. ✓
- An increase in temperature favours the endothermic reaction/Toename in temperatuur bevoordeel die endotermiese reaksie. ✓

(3)

6.4.2

POSITIVE MARKING FROM Q6.2.1./POSITIEWE NASIEN VANAF V6.2.1.

Marking guidelines/Nasienriglyne

- Calculate total volume/mol of gas at equilibrium/Bereken totale volume/mol gas by ewewig: $0,162 + 2,44 = 2,606 \text{ dm}^3 / \text{mol}$ ✓
OR/OF
Calculate the total concentration at equilibrium/Bereken die totale konsentrasie by ewewig: $0,054 + 0,813 = 0,867 \text{ mol} \cdot \text{dm}^{-3}$
- Calculate percentage of ANY one gas/Bereken persentasie van ENIGE een gas (CO₂ or/of CO). ✓
- Final answer/Finale antwoord: $T = 827^\circ \text{C}$ ✓

OPTION 1/OPSIE 1

$$V_{\text{total eq}} = 0,162 + 2,44 \checkmark$$

$$= 2,606 \text{ dm}^3$$

$$\% \text{ CO}_2 = \frac{0,162}{2,606} \times 100 \checkmark$$

$$= 6,225 \%$$

OR/OF

$$\% \text{ CO} = \frac{2,44}{2,606} \times 100 \checkmark$$

$$= 93,63 \%$$

OPTION 2/OPSIE 2

$$C_{\text{total eq}} = 0,054 + 0,813$$

$$= 0,867 \text{ mol} \cdot \text{dm}^{-3}$$

$$\% \text{ CO}_2 = \frac{0,054}{0,867} \times 100 \checkmark$$

$$= 6,228 \%$$

OR/OF

$$\% \text{ CO} = \frac{0,813}{0,867} \times 100 \checkmark$$

$$= 93,77 \%$$

$$\therefore T = 827^\circ \text{C} \checkmark$$

(3)

[22]

QUESTION 5/VRAAG 5

- 5.1.1 (Reaction) rate/Reaksiestempo ✓ (1)
- 5.1.2 Surface area/state of division /particle size ✓
Reaksie-oppervlak/toestand van verdeeldheid/deeltjie grootte (1)
- 5.2.1 (Decreasing gradient indicates) rate of reaction is decreasing. ✓
(Afnemende gradiënt dui aan dat) reaksiestempo afneem. (1)
- 5.2.2 (Gradient is zero, indicates) reaction rate is zero ✓
(Gradiënt is nul, wat aandui dat) reaksiestempo nul is. (1)
- 5.3 ave rate/gem tempo = $\frac{\Delta V}{\Delta t}$
= $\frac{500 \checkmark(-0)}{60 \checkmark(-0)} = 8,33 \text{ (cm}^3 \cdot \text{s}^{-1})$ ✓ (3)
- 5.4 Equal to/Gelyk aan ✓ (1)
- 5.5 Greater than/Groter as ✓

Experiment C/Eksperiment C:

- Surface area of CaCO₃ powder is greater than that of CaCO₃ granules./ More particles are exposed /More particles with correct orientation ✓
- More effective collisions per unit time/Higher frequency of effective collisions. ✓
- Increase in reaction rate. ✓
- Reaksieoppervlak van CaCO₃-poeier is groter (as die van CaCO₃-korrels /Meer deeltjies met korrekte oriëntasie.
- Meer effektiewe botsings per eenheid tyd./Hoër frekwensie van effektiewe botsings
- Toename in reaksie tempo

OR/OF

Experiment A/Eksperiment A:

- Surface area of CaCO₃ granules is smaller/Fewer particles are exposed (than that of powdered CaCO₃). Less particles with correct orientation ✓
- Less effective collisions per unit time./Lower frequency of effective collisions. ✓
- Decrease in reaction rate. ✓.
- Reaksieoppervlak van CaCO₃ is kleiner/Minder deeltjies is blootgestel (as die van die verpoeierde CaCO₃)./ Minder deeltjies met korrekte oriëntasie
- Minder effektiewe botsings per eenheidtyd./Laer frekwensie van effektiewe botsings.
- Afname in reaksie tempo (4)

Marking criteria/Nasiennriglyne:

- Divide volume by 25,7 in / Deel volume deur 25,7 in $n = \frac{V}{V_M}$. ✓
If no substitution step shown, award mark for answer: 0,0195 mol
Indien geen vervanging stap getoon is nie, ken punt toe vir antwoord: 0,0195 mol
- Ratio/Verhouding: $n(\text{CO}_2) = n(\text{CaCO}_3)$. ✓
- Substitute/Vervang 100 in $n = \frac{m}{M}$ or in ratio / of in verhouding. ✓
- Final answer/Finale antwoord: 1,95 g to/tot 2 g. ✓

OPTION 1/OPSIE 1

$$n(\text{CO}_2) = \frac{V}{V_m} = \frac{0,5}{25,7} \checkmark$$

$$= 0,0195 \text{ mol}$$

$$n(\text{CaCO}_3) = n(\text{CO}_2) = 0,0195 \text{ mol} \checkmark$$

$$m(\text{CaCO}_3) = nM$$

$$= 0,0195(100)$$

$$= 1,95 \text{ g} \checkmark$$

OPTION 2/OPSIE 2

$$25,7 \text{ dm}^3 \dots\dots\dots 1 \text{ mol}$$

$$0,5 \text{ dm}^3 \dots\dots\dots 0,0195 \text{ mol} \checkmark$$

$$100 \text{ g} \checkmark \dots\dots\dots 1 \text{ mol}$$

$$x \dots\dots\dots 0,0195 \text{ mol} \checkmark$$

$$x = m(\text{CaCO}_3) = 1,95 \text{ g} \checkmark$$

OPTION 3/OPSIE 3

$$n(\text{CO}_2) = \frac{V}{V_m} = \frac{0,5}{25,7} \checkmark$$

$$= 0,0195 \text{ mol}$$

$$0,0195 \text{ mol CO}_2 \equiv 0,856 \text{ g CO}_2 \checkmark$$

$$m(\text{CO}_2) \text{ produced} : m(\text{CaCO}_3)$$

$$44 \text{ g} \quad \quad \quad : 100 \text{ g} \checkmark$$

$$0,856 \quad \quad \quad : x$$

$$x = 1,95 \text{ g} \checkmark \text{ CaCO}_3$$

(4)
[16]**QUESTION 6/VRAAG 6**

- 6.1 Products can be converted back to reactants. ✓
Produkke kan omgeskakel word na reaktanse.

OR/OF

Both forward and reverse reactions can take place.
Beide voor-en terugwaartse reaksies kan plaasvind.

OR/OF

A reaction which can take place in both directions.
'n Reaksie wat in beide rigtings kan plaasvind.

(1)

- 6.2.1 Remains the same/Bly dieselfde ✓

(1)

- 6.2.2 Increases/Toeneem ✓

(1)

- 6.3
- (When pressure is increased) the reaction that leads to the smaller amount of gas / side with less molecules/number of moles is favoured. ✓
(Wanneer die druk verhoog word,) word die reaksie wat tot die kleiner hoeveelheid gas /minder gas molekule/aantal mol lei, bevoordeel.
 - The reverse reaction is favoured. ✓
Die terugwaartse reaksie word bevoordeel.

(2)

6.4 Endothermic/Endotermies ✓

- K_c decreases with decrease in temperature. ✓
- Reverse reaction is favoured. / Concentration of reactants increases. / Concentration of products decreases./Yield decreases ✓
- Decrease in temperature favours an exothermic reaction. ✓
- K_c neem af met afname in temperatuur.
- Terugwaartse reaksie word bevoordeel./Konsentrasie van reaktanse neem toe./Konsentrasie van produkte neem af./Opbrengs neem af
- Afname in temperatuur bevoordeel 'n eksotermiese reaksie.

OR/OF

- K_c increases with increase in temperature. ✓
- Forward reaction is favoured. / Concentration of reactants decreases. / Concentration of products increases./Yield increases ✓
- Increase in temperature favours an endothermic reaction. ✓
- K_c neem toename met toename in temperatuur.
- Voorwaartse reaksie word bevoordeel./Konsentrasie van produkte neem toe./Konsentrasie van reaktanse neem af./Opbrengs neem toe
- Toename in temperatuur bevoordeel 'n endotermiese reaksie

(4)

6.5

CALCULATIONS USING NUMBER OF MOLES

Mark allocation

- Correct K_c expression (formulae in square brackets). ✓
- Substitution of equilibrium concentrations into K_c expression. ✓
- Substitution of K_c value. ✓
- Multiply equilibrium concentrations of I_2 and I by $12,3 \text{ dm}^3$. ✓ (**OPTION 1**)
- Multiply equilibrium concentrations of I by $12,3 \text{ dm}^3$ and divide equilibrium mol of I_2 by $12,3 \text{ dm}^3$. ✓ (**OPTION 2**)
- Change in $n(I) = n(I \text{ at equilibrium})$. ✓
- **USING** ratio/**GEBRUIK** verhouding: $I_2 : I = 1 : 2$ ✓
- Initial $n(I_2) = \text{equilibrium } n(I_2) + \text{change in } n(I_2)$. ✓
- Substitute $254 \text{ g} \cdot \text{mol}^{-1}$ as molar mass for I_2 . ✓
- Final answer: $(26 \text{ g} - 27,94 \text{ g})$. ✓

BEREKENINGE WAT AANTAL MOL GEBRUIK

Puntetoekenning:

- Korrekte K_c -uitdrukking (formules in vierkanthakies).
- Vervanging van ewewigskonsentrasies in K_c -uitdrukking.
- Vervanging van K_c -waarde. ✓
- Vermenigvuldig ewewigskonsentrasies van I_2 en I met $12,3 \text{ dm}^3$. (**OPSIE 1**)
- Vermenigvuldig ewewigskonsentrasies van I met $12,3 \text{ dm}^3$ en deel ewewigsmol I_2 met $12,3 \text{ dm}^3$ (**OPSIE 2**)
- Verandering in $n(I) = n(I \text{ by ewewig})$
- **GEBRUIK** verhouding: $I_2 : I = 1 : 2$ ✓
- Aanvanklike $n(I_2) = \text{ewewigs } n(I_2) + \text{verandering in } n(I_2)$.
- Vervang $254 \text{ g} \cdot \text{mol}^{-1}$ as molêre massa van I_2 .
- Finale antwoord: $(26 \text{ g} - 27,94 \text{ g})$

OPTION 1/OPSIE 1

$$K_c = \frac{[I]^2}{[I_2]} \checkmark$$

$$3,76 \times 10^{-3} = \frac{(4,79 \times 10^{-3})^2}{[I_2]} \checkmark$$

$$\therefore [I_2] = 6,102 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3}$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{8}{9}$

Wrong K_c expression/Verkeerde K_c -uitdrukking: Max./Maks. $\frac{6}{9}$

	I_2	I	
Initial mass (g) Aanvangsmassa (g)	$(0,1045)(254) \checkmark$ $= 26,543 \text{ g} \checkmark$		
Initial quantity (mol) Aanvangshoeveelheid (mol)	0,1045	0	
Change (mol) Verandering (mol)	$\checkmark \left\{ \begin{array}{l} 0,0295 \\ 0,0751 \end{array} \right.$	0,0589 $\checkmark$	Using ratio $\checkmark$
Quantity at equilibrium (mol)/ Hoeveelheid by ewewig (mol)	0,0751	0,0589	
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$) Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	$6,102 \times 10^{-3}$	$4,79 \times 10^{-3}$	$\times 12,3 \checkmark$

OPTION 2/OPSIE 2

	I_2	I	
Initial amount (moles) Aanvangshoeveelheid (mol)	x	0	
Change in amount (moles) Verandering in hoeveelheid (mol)	0,0295 $\checkmark$	0,0589	ratio $\checkmark$ verhouding
Equilibrium amount (moles) hoeveelheid (mol)	$x - 0,0295$	0,0589 $\checkmark$	
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$) Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	$\frac{x - 0,0295}{12,3}$	$4,79 \times 10^{-3}$	$\times 12,3$ and divide by 12,3 $\checkmark$

$$K_c = \frac{[I]^2}{[I_2]} \checkmark$$

$$3,76 \times 10^{-3} \checkmark = \frac{(4,79 \times 10^{-3})^2}{\frac{x - 0,0295}{12,3}} \checkmark$$

$$x = 0,1045 \text{ mol}$$

$$\begin{aligned} \therefore m &= nM \checkmark \\ &= (0,1045)(254) \\ &= 26,543 \text{ g} \checkmark \end{aligned}$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{8}{9}$

Wrong K_c expression/Verkeerde K_c -uitdrukking: Max./Maks. $\frac{6}{9}$

CALCULATIONS USING CONCENTRATION

Mark allocation

- Correct K_c expression (formulae in square brackets). ✓
- Substitution of equilibrium concentrations into K_c expression. ✓
- Substitution of K_c value ✓
- Change in $n(I) = n(I \text{ at equilibrium})$. ✓
- **USING** ratio: $I_2 : I = 1 : 2$ ✓
- Initial $[I_2] = \text{equilibrium } [I_2] + \text{change in } [I_2]$. ✓
- Divide by $12,3 \text{ dm}^3$. ✓
- Substitute $254 \text{ g} \cdot \text{mol}^{-1}$ as molar mass for I_2 . ✓
- Final answer $26,543 \text{ g}$. ✓

BEREKENINGE WAT KONSENTRASIE GEBRUIK

Puntetoekenning

- Korrekte K_c -uitdrukking (formules in vierkanthakies).
- Vervanging van ewewigskonsentrasies in K_c -uitdrukking.
- Vervanging van K_c -waarde.
- Verandering in $n(I) = n(I \text{ by ewewig})$.
- **GEBRUIK** verhouding $I_2 : I = 1 : 2$
- Aanvanklike $[I_2] = \text{ewewigs } [I_2] + \text{verandering in } [I_2]$.
- Deel deur $12,3 \text{ dm}^3$. ✓
- Vervang $254 \text{ g} \cdot \text{mol}^{-1}$ as molêre massa van I_2 .
- Finale antwoord: $26,543 \text{ g}$

OPTION 3/OPSIE 3

$$K_c = \frac{[I]^2}{[I_2]} \quad \checkmark$$

$$3,76 \times 10^{-3} \checkmark = \frac{(4,79 \times 10^{-3})^2}{[I_2]} \quad \checkmark$$

$$[I_2] = 6,102 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3}$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{8}{9}$

Wrong K_c expression/Verkeerde K_c -uitdrukking: Max./Maks. $\frac{6}{9}$

	I_2	I	
Initial concentration ($\text{mol} \cdot \text{dm}^{-3}$) Aanvangskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	$8,497 \times 10^{-3}$	0	
Change ($\text{mol} \cdot \text{dm}^{-3}$) Verandering ($\text{mol} \cdot \text{dm}^{-3}$)	$2,395 \times 10^{-3}$	$4,79 \times 10^{-3} \checkmark$	Using ratio ✓
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$) Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	$6,102 \times 10^{-3}$	$4,79 \times 10^{-3}$	

$$c = \frac{m}{MV}$$

$$8,497 \times 10^{-3} = \frac{m}{(254)(12,3)} \quad \checkmark$$

$$\therefore m = 26,546 \text{ g}$$

(9)
[18]

QUESTION 5/VRAAG 5

5.1

NOTE/LET WEL

Give the mark for per unit time only if in context of reaction rate.

Gee die punt vir per eenheidtyd slegs indien in konteks van reaksietempo.

ANY ONE

- Change in concentration ✓ of products/reactants per (unit) time. ✓
- Change in amount/number of moles/volume/mass of products or reactants per (unit) time.
- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time.
- Rate of change in concentration/amount of moles/number of moles/volume/
mass. ✓✓ (2 or 0)

ENIGE EEN

- Verandering in konsentrasie ✓ van produkte/reaktanse per (eenheid) tyd. ✓
- Verandering in hoeveelheid/getal mol/volume/massa van produkte of reaktanse per (eenheid) tyd.
- Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktanse gebruik per (eenheid) tyd.
- Tempo van verandering in konsentrasie/ hoeveelheid mol/getal mol/
volume/ massa. ✓✓ (2 of 0)

(2)

5.2

Reaction rate decreases./Concentration of HCl decreases./Concentration of reactant decreases./Reactants are used up/Mass of CaCO₃ decreases or is used up. ✓

Reaksietempo neem af./Konsentrasie van HCl neem af./Konsentrasie van reaktans neem af./Reaktanse word opgebruik./Massa van CaCO₃ neem af of word opgebruik. ✓

(1)

5.3

5.3.1

Exothermic/Eksotermies ✓

(1)

5.3.2

- Gradient increases/becomes steeper. / Curve becomes steeper. ✓
- Reaction rate increases/More (or larger volume) of CO₂ is produced per unit time. ✓
- Temperature increases./Energy is released/Average kinetic energy of the molecules increases. ✓

- Gradiënt neem toe/word steiler. / Kurwe word steiler. ✓
- Reaksietempo neem toe./Meer (of groter volume) CO₂ word produseer per eenheidtyd. ✓
- Temperatuur neem toe./Energie word vrygestel./Gemiddelde kinetiese energie van molekule neem toe. ✓

(3)

Marking criteria

- $m(\text{pure CaCO}_3) = \frac{82,5}{100} \times 15 \checkmark / V(\text{CO}_2) = \frac{82,5}{100} \times V(\text{CO}_2) \text{ from/uit } 15 \text{ g CaCO}_3$
- Divide by 100 g·mol⁻¹. ✓
- Use mol ratio: $n(\text{CO}_2) = n(\text{CaCO}_3)$. ✓
- Multiply $n(\text{CO}_2)$ by 24 000 cm³/24 dm³. ✓
- Final answer: 2 976 cm³ ✓
- **Range:** 2880 to 2970 cm³ / 2,88 to 2,97 dm³

Nasienkriteria

- $m(\text{suiwer CaCO}_3) = \frac{82,5}{100} \times 15 \checkmark / V(\text{CO}_2) = \frac{82,5}{100} \times V(\text{CO}_2) \text{ uit } 15 \text{ g CaCO}_3$
- Deel deur 100 g·mol⁻¹. ✓
- Gebruik molverhouding: $n(\text{CO}_2) = n(\text{CaCO}_3)$. ✓
- Vermenigvuldig $n(\text{CO}_2)$ met 24 000 cm³/24 dm³. ✓
- Finale antwoord: 2 976 cm³ ✓
- **Gebied:** 2880 tot 2970 cm³ / 2,88 tot 2,97 dm³

OPTION 1/OPSIE 1

$$m(\text{pure/suiwer CaCO}_3) = \frac{82,5}{100} \times 15 \checkmark$$

$$= 12,375 \text{ g}$$

$$n(\text{pure/suiwer CaCO}_3) = \frac{m}{M}$$

$$= \frac{12,375}{100} \checkmark$$

$$= 0,124 \text{ mol}$$

$$n(\text{CO}_2) = n(\text{CaCO}_3)$$

$$= 0,124 \text{ mol} \checkmark$$

$$V(\text{CO}_2) = 0,124 \times 24\,000 \checkmark$$

$$= 2\,976 \text{ cm}^3 \checkmark$$

OR/OF

$$V(\text{CO}_2) = 0,124 \times 24 \checkmark$$

$$= 2,98 \text{ dm}^3 \checkmark$$

OPTION 2/OPSIE 2IF 15 g PURE CaCO₃ reacts:INDIEN 15 g SUIWER CaCO₃ reageer:

$$n(\text{CaCO}_3) = \frac{m}{M}$$

$$= \frac{15}{100} \checkmark$$

$$= 0,15 \text{ mol}$$

$$n(\text{CO}_2) = n(\text{CaCO}_3) \checkmark$$

$$= 0,15 \text{ mol}$$

$$n(\text{CO}_2) = \frac{V}{V_M}$$

$$0,15 = \frac{V}{24\,000} \checkmark / 0,15 = \frac{V}{24}$$

$$V = 3\,600 \text{ cm}^3 / V = 3,6 \text{ dm}^3$$

Actual CO₂ formed:Werklike CO₂ gevorm:

$$V(\text{CO}_2) = \frac{82,5}{100} \times 3\,600 / 3,6 \checkmark$$

$$= 2\,976 \text{ cm}^3 / 2,976 \text{ dm}^3 \checkmark$$

(5)

OPTION 3/OPSIE 3

IF 15 g PURE CaCO_3 reacts:/INDIEN 15 g SUIWER CaCO_3 reageer:

$$n(\text{CaCO}_3) = \frac{m}{M}$$

$$= \frac{15}{100} \checkmark$$

$$= 0,15 \text{ mol}$$

$$n(\text{CO}_2) = n(\text{CaCO}_3) \checkmark$$

$$= 0,15 \text{ mol}$$

$$n(\text{CO}_2) = \frac{m}{M}$$

$$m(\text{CO}_2) = 0,15 \times 44$$

$$= 6,6 \text{ g}$$

$$82,5 = \frac{m_{\text{actual/werklik}}}{6,6} \times 100 \checkmark$$

$$m_{\text{(actual/werklik)}} = 5,445 \text{ g}$$

$$n(\text{CO}_2) = \frac{m}{M}$$

$$= \frac{5,445}{44}$$

$$= 0,12375 \text{ mol}$$

$$n(\text{CO}_2) = \frac{V}{V_M}$$

$$0,12375 = \frac{V}{24\,000} \checkmark / 0,12375 = \frac{V}{24}$$

$$V = 2\,976 \text{ cm}^3 / 2,976 \text{ dm}^3 \checkmark$$

(5)

5.5 Increases/Toeneem ✓

(1)

5.6

- More (CaCO_3) particles with correct orientation/exposed./ Greater (exposed) surface area. ✓
- More effective collisions per unit time./Higher frequency of effective collisions. ✓
- Meer (CaCO_3)-deeltjies met korrekte oriëntasie/blootgestel./ Groter (blootgestelde) reaksieoppervlakte. ✓
- Meer effektiewe botsings per eenheid tyd./Hoër frekwensie van effektiewe botsings. ✓

NOTE/LET WEL

- If explanation in terms of CONCENTRATION: No mark for bullet 1.
Indien verduideliking in terme van KONSENTRASIE: Geen punt vir kolpunt 1.
- Bullets are marked independently./Kolpunte word onafhanklik nagesien.

(2)

[15]

QUESTION 6/VRAAG 6

6.1 (The stage in a chemical reaction when the) rate of forward reaction equals the rate of reverse reaction. ✓✓ (2 or 0)

OR

(The stage in a chemical reaction when the) concentrations of reactants and products remain constant. (2 or 0)

(Die stadium in 'n chemiese reaksie wanneer die) tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. (2 of 0)

OF

(Die stadium in 'n chemiese reaksie wanneer die) konsentrasies van reaktanse en produkte konstant bly. (2 of 0)

(2)

6.2

6.2.1 Negative/Negatief ✓

(1)

6.2.2 • Increase in temperature favours an endothermic reaction.

Accept: Decrease in temperature favours an exothermic. ✓

• Reverse reaction is favoured./Concentration of reactants increases./Concentration of products decreases. ✓

• (Forward) reaction is exothermic.

Accept: Reverse reaction is endothermic. ✓

• Toename in temperatuur bevoordeel 'n endotermiese reaksie. ✓

Aanvaar: Afname in temperatuur bevoordeel die eksotermiese reaksie.

• Terugwaartse reaksie word bevoordeel./Konsentrasie van reaktanse neem toe./Konsentrasie van produkte neem af. ✓

• (Voorwaartse) reaksie is eksotermies.

Aanvaar: Terugwaartse reaksie is endotermies. ✓

(3)

CALCULATIONS USING NUMBER OF MOLES**BEREKENINGE WAT GETAL MOL GEBRUIK****Marking criteria:**

- a) Initial $n(P)$ and $n(Q_2)$ and $n(PQ)$ from table. ✓
 b) Change in $n(P)$ = equilibrium $n(P)$ – initial $n(P)$. ✓
 c) **USING** ratio: $P : Q_2 : PQ = 2 : 1 : 2$ ✓
 d) Equilibrium $n(Q_2)$ = initial $n(Q_2)$ + change in $n(Q_2)$ } ✓
 Equilibrium $n(PQ)$ = initial $n(PQ)$ - change in $n(PQ)$ } ✓
 e) Divide **equilibrium** amounts of P and Q_2 and PQ by 2 dm^3 . ✓
 f) Correct K_c expression (**formulae in square brackets**). ✓
 g) Substitution of equilibrium concentrations into K_c expression. ✓
 h) Final answer: 10,889 ✓

Nasienkriteria:

- a) Aanvanklike $n(P)$ en $n(Q_2)$ en $n(PQ)$ uit tabel. ✓
 b) Verandering in $n(P)$ = ewewigs $n(P)$ – aanvanklike $n(P)$. ✓
 c) **GEBRUIK** verhouding: $P : Q_2 : PQ = 2 : 1 : 2$ ✓
 d) Ewewig $n(Q_2)$ = aanvanklike $n(Q_2)$ + verandering in $n(Q_2)$ } ✓
 Ewewig $n(PQ)$ = aanvanklike $n(PQ)$ - verandering in $n(PQ)$ } ✓
 e) Deel **ewewigshoeveelhede** van P en Q_2 en PQ deur 2 dm^3 . ✓
 f) Korrekte K_c -uitdrukking (**formules in vierkanthakies**). ✓
 g) Vervanging van ewewigskonsentrasies in K_c -uitdrukking. ✓
 h) Finale antwoord: 10,89 / 10,889 ✓

(3)

OPTION 1/OPSIE 1

	P	Q_2	PQ	
Initial quantity (mol) Aanvangshoeveelheid (mol)	0,8	0,8	3,2	✓(a)
Change (mol) Verandering (mol)	0,4 ✓(b)	0,2	0,4	✓(c)
Quantity at equilibrium (mol)/ Hoeveelheid by ewewig (mol)	1,2	1,0	2,8	✓(d)
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$) Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	0,6	0,5	1,4	✓(e)

$$K_c = \frac{[PQ]^2}{[Q_2][P]^2} \quad \checkmark(f)$$

$$= \frac{1,4^2}{(0,5)(0,6)^2} \quad \checkmark(g)$$

$$= 10,89 \quad \checkmark(h)$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/Verkeerde K_c -uitdrukking:
Max./Maks. $\frac{5}{8}$

OPTION 2/OPSIE 2

	PQ	P	Q ₂	
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	3,2	0,8	0,8	✓(a)
Change (mol) <i>Verandering (mol)</i>	0,4	0,4 ✓(b)	0,2 ✓(c)	
Quantity at equilibrium (mol)/ <i>Hoeveelheid by ewewig (mol)</i>	2,8	1,2 ✓(d)	1,0	
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	1,4	0,6	0,5	✓(e)

Reverse reaction

Terugwaartse reaksie:

$$K_c = \frac{[P]^2[Q_2]}{[PQ]^2} \quad \checkmark(f)$$

$$= \frac{(0,6)^2(0,5)}{(1,4)^2} \quad \checkmark(g)$$

$$K_c = 0,09$$

Forward reaction/*Voorwaartse reaksie:*

$$K_c = \frac{1}{0,09} \\ = 10,89 \quad \checkmark(h)$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/*Verkeerde K_c-uitdrukking*: Max./Maks. $\frac{5}{8}$

CALCULATIONS USING NUMBER OF MOLES BEREKENINGE WAT GETAL MOL GEBRUIK

Marking criteria:

- Initial $n(P) = 4$ mol and $n(Q_2) = 2,4$ mol and $n(PQ) = 0$ ✓
- Change in $n(P) = \text{equilibrium } n(P) - \text{initial } n(P) = 2,8$ mol. ✓
- USING ratio: $P : Q_2 : PQ = 2 : 1 : 2$ ✓
- Equilibrium $n(Q_2) = \text{initial } n(Q_2) + \text{change in } n(Q_2)$ } ✓
Equilibrium $n(PQ) = \text{initial } n(PQ) - \text{change in } n(PQ)$ }
- Divide equilibrium amounts of P and Q₂ and PQ by 2 dm^3 . ✓
- Correct K_c expression (formulae in square brackets). ✓
- Substitution of equilibrium concentrations into K_c expression. ✓
- Final answer: $10,89 / 10,889$ ✓

Nasienkriteria:

- Aanvanklike $n(P) = 4$ mol en $n(Q_2) = 2,4$ mol en $n(PQ) = 0$. ✓
- Verandering in $n(P) = \text{ewewigs } n(P) - \text{aanvanklike } n(P) = 2,8$ mol. ✓
- GEBRUIK verhouding: $P : Q_2 : PQ = 2 : 1 : 2$ ✓
- Ewewig $n(Q_2) = \text{aanvanklike } n(Q_2) + \text{verandering in } n(Q_2)$ } ✓
Ewewig $n(PQ) = \text{aanvanklike } n(PQ) - \text{verandering in } n(PQ)$ }
- Deel ewewigshoeveelhede van P en Q₂ en PQ deur 2 dm^3 . ✓
- Korrekte K_c -uitdrukking (formules in vierkanthakies). ✓
- Vervanging van ewewigskonsentrasies in K_c -uitdrukking. ✓
- Finale antwoord: $10,89 / 10,889$ ✓

OPTION 3/OPSIE 3

	P	Q ₂	PQ	
Initial quantity (mol) Aanvangshoeveelheid (mol)	4	2,4	0	✓(a)
Change (mol) Verandering (mol)	2,8 ✓(b)	1,4	2,8	✓(c)
Quantity at equilibrium (mol)/ Hoeveelheid by ewewig (mol)	1,2	1,0	2,8	✓(d)
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$) Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	0,6	0,5	1,4	✓(e)

$$K_c = \frac{[PQ]^2}{[Q_2][P]^2} \quad \checkmark(f)$$

$$= \frac{1,4^2}{(0,5)(0,6)^2} \quad \checkmark(g)$$

$$= 10,89 \quad \checkmark(h)$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/Verkeerde K_c -uitdrukking:
Max./Maks. $\frac{5}{8}$

CALCULATIONS USING CONCENTRATION
BEREKENINGE WAT KONSENTRASIE GEBRUIK

Marking criteria:

- Initial $c(P)$ and $c(Q_2)$ and $c(PQ)$ from table. ✓
- Change in $c(P)$ = equilibrium $c(P)$ – initial $c(P)$. ✓
- USING** ratio: $P : Q_2 : PQ = 2 : 1 : 2$ ✓
- Equilibrium $c(Q_2)$ = initial $c(Q_2)$ + change in $c(Q_2)$ } ✓
 Equilibrium $c(PQ)$ = initial $c(PQ)$ - change in $c(PQ)$ }
- Divide initial amounts of P and Q_2 and PQ by 2 dm^3 . ✓
- Correct K_c expression (formulae in square brackets). ✓
- Substitution of equilibrium concentrations into K_c expression. ✓
- Final answer: $10,89 / 10,889$ ✓

Nasiengriglyne:

- Aanvanklike $c(P)$ en $c(Q_2)$ en $c(PQ)$ uit tabel. ✓
- Verandering in $c(P)$ = ewewigs $c(P)$ – aanvanklike $c(P)$. ✓
- GEBRUIK** verhouding: $P : Q_2 : PQ = 2 : 1 : 2$ ✓
- Ewewig $c(Q_2)$ = aanvanklike $c(Q_2)$ + verandering in $c(Q_2)$ } ✓
 Ewewig $c(PQ)$ = aanvanklike $c(PQ)$ - verandering in $c(PQ)$ }
- Deel **aanvangshoeveelhede** van P en Q_2 en PQ deur 2 dm^3 . ✓
- Korrekte K_c -uitdrukking (formules in vierkanthakies). ✓
- Vervanging van ewewigskonsentrasies in K_c -uitdrukking. ✓
- Finale antwoord: $10,89 / 10,889$ ✓

OPTION 4/OPSIE 4

	P	Q_2	PQ	
Initial concentration ($\text{mol} \cdot \text{dm}^{-3}$)				
Aanvangskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	0,4	0,4	1,6	✓ (a)
Change in concentration ($\text{mol} \cdot \text{dm}^{-3}$)				
Verandering in konsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	0,2 ✓ (b)	0,1	0,2	✓ (c)
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$)				
Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	0,6	0,5	1,4	✓ (d)

$$K_c = \frac{[PQ]^2}{[Q_2][P]^2} \quad \checkmark \text{ (f)}$$

$$= \frac{1,4^2}{(0,5)(0,6)^2} \quad \checkmark \text{ (g)}$$

$$= 10,89 \quad \checkmark \text{ (h)}$$

No K_c expression, correct substitution/Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{7}{8}$

Wrong K_c expression/Verkeerde K_c -uitdrukking: Max./Maks. $\frac{5}{8}$

(8)

6.2.4 Remains the same/Bly dieselfde ✓

Only temperature can change K_c ./Temperature remains constant. ✓
 Slegs temperatuur kan K_c verander./Temperatuur bly konstant.

(2)

6.3

6.3.1 Increases/Toeneem ✓

(1)

6.3.2 Decreases/Afneem ✓

(1)

[18]

QUESTION 5/VRAAG 5

- 5.1 B ✓
- The catalyst provides an alternative route of lower activation energy. ✓
 - More molecules have enough/sufficient (kinetic) energy./More molecules have (kinetic) energy equal to or higher than the activation energy. ✓
 - More effective collisions per unit time./Higher frequency of effective collisions. ✓
 - *Die katalisator verskaf 'n alternatiewe roete van laer aktiveringsenergie.*
 - *Meer molekule het genoeg/voldoende (kinetiese) energie./Meer molekule het (kinetiese) energie gelyk aan of groter hoër as die aktiveringsenergie.*
 - *Meer effektiewe botsings per eenheidtyd./Hoër frekwensie van effektiewe botsings.*
- (4)
- 5.2 Y ✓✓ (2)
- 5.3
- 5.3.1 $560 \text{ (cm}^3\text{)} / 0,56 \text{ dm}^3$ ✓✓ (2)

5.3.2 **POSITIVE MARKING FROM QUESTION 5.3.1.**
POSITIEWE NASIEN VANAF VRAAG 5.3.1.

Marking criteria: (a) Substitute <u>24 000</u> and <u>560/24</u> and <u>0,56</u> $\text{in } n = \frac{V}{V_m}$ ✓ (b) USE mol ratio: $n(\text{H}_2\text{O}) : n(\text{O}_2) = 2 : 1$ ✓ (c) Substitute <u>18</u> and <u>$n(\text{H}_2\text{O})$</u> in $m = nM$ ✓ (d) Final answer: <u>0,83 g</u> ✓ Range: 0,72 to 0,9 g	Nasienkriteria: (a) Vervang <u>24 000</u> en <u>560/24</u> en <u>0,56</u> $\text{in } n = \frac{V}{V_m}$ ✓ (b) GEBRUIK molverhouding: $n(\text{H}_2\text{O}) : n(\text{O}_2) = 2 : 1$ ✓ (c) Vervang <u>18</u> en <u>$n(\text{H}_2\text{O})$</u> in $m = nM$ ✓ (d) Finale antwoord: <u>0,83 g</u> ✓ Gebied: 0,72 tot 0,9 g
OPTION 1/OPSIE 1 $n(\text{O}_2) = \frac{V}{V_m}$ $= \frac{560}{24\,000} \text{ ✓(a)}$ $= 0,023 \text{ mol (0,0233)}$ $n(\text{H}_2\text{O}) = 2n(\text{O}_2)$ $n(\text{H}_2\text{O}) = 2(0,023) \text{ ✓(b)}$ $= 0,046 \text{ mol (0,0467)}$ $m = nM$ $= 0,046 \times 18 \text{ ✓(c)}$ $= 0,83 \text{ g ✓(d)}$	OPTION 2/OPSIE 2 $\left. \begin{array}{l} 1 \text{ mol} 24\,000 \text{ cm}^3 \\ x \text{ mol} 560 \text{ cm}^3 \end{array} \right\} \text{ ✓(a)}$ $x = 0,023 \text{ mol (0,0233)}$ $n(\text{H}_2\text{O}) = 2n(\text{O}_2)$ $n(\text{H}_2\text{O}) = 2(0,023) \text{ ✓(b)}$ $= 0,046 \text{ mol (0,0467)}$ $m = nM$ $= 0,0466 \times 18 \text{ ✓(c)}$ $= 0,83 \text{ g ✓(d)}$

(4)

- 5.4
- 5.4.1 $0 \text{ (g} \cdot \text{s}^{-1}\text{)} / \text{zero} / \text{nul}$ ✓ (1)
- 5.4.2 Greater than/Groter as ✓ (1)

Marking criteria a) Substitute 0,9 g in $\frac{m}{M}$ ✓ b) Substitute 32 in $\frac{m}{M}$ ✓ c) USE mol /rate ratio: $n(\text{H}_2\text{O}_2) : n(\text{O}_2) = 2 : 1$ ✓ d) Substitute $2,1 \times 10^{-3}$ and $n(\text{H}_2\text{O}_2)$ in rate formula ✓ OR: Substitute rate O_2 ($1,05 \times 10^{-3}$) and $n(\text{O}_2)$ in rate formula OR: Substitute rate O_2 ($0,0336 \text{ g} \cdot \text{s}^{-1}$) in rate formula e) Final correct answer: 26,67 (s) ✓ Range: 26,67 to 28,57 (s)	Nasienkriteria: a) Vervang 0,9 g in $\frac{m}{M}$ ✓ b) Vervang 32 in $\frac{m}{M}$ ✓ c) GEBRUIK mol-/tempoverhouding: $n(\text{H}_2\text{O}_2) : n(\text{O}_2) = 2 : 1$ ✓ d) Vervang $2,1 \times 10^{-3}$ en $n(\text{H}_2\text{O}_2)$ in tempoformule ✓ OF: Vervang tempo O_2 ($1,05 \times 10^{-3}$) en $n(\text{O}_2)$ in tempoformule OF: Vervang tempo O_2 ($0,0336 \text{ g} \cdot \text{s}^{-1}$) in tempoformule e) Finale korrekte antwoord: 26,67 (s) ✓ Gebied: 26,67 tot 28,57 (s)
OPTION 1/OPSIE 1 $n(\text{O}_2) = \frac{m}{M}$ $= \frac{0,9}{32} \checkmark \text{(a)}$ $= 0,028 \text{ mol (0,0281)} \checkmark \text{(b)}$ $n(\text{H}_2\text{O}_2) = 2n(\text{O}_2)$ $= 2(0,028) \checkmark \text{(c)}$ $= 0,056$ $\text{rate/tempo} = \frac{\Delta n}{\Delta t}$ $2,1 \times 10^{-3} = \frac{\checkmark \text{(d)} 0,056 - 0}{\Delta t}$ $\Delta t = 26,67 \text{ (s)} \checkmark \text{(e)}$	OPTION 2/OPSIE 2 $1 \text{ mol} \dots\dots\dots 32 \text{ g} \checkmark \text{(b)}$ $x \text{ mol} \dots\dots\dots 0,9 \text{ g} \checkmark \text{(a)}$ $x = 0,0275 \text{ mol}$ $n(\text{H}_2\text{O}_2) = 2n(\text{O}_2)$ $= 2(0,0275) \checkmark \text{(c)}$ $= 0,056 \text{ mol}$ $\text{rate/tempo} = \frac{\Delta n}{\Delta t}$ $= \frac{\checkmark \text{(d)} 0,056 - 0}{\Delta t}$ $2,1 \times 10^{-3} = \frac{\Delta t = 26,67 \text{ (s)} \checkmark \text{(e)}}{\Delta t}$
OPTION 3/OPSIE 3 $n(\text{O}_2) = \frac{m}{M}$ $= \frac{0,9}{32} \checkmark \text{(a)}$ $= 0,028 \text{ mol (0,0281)} \checkmark \text{(b)}$ $\text{Rate}(\text{O}_2) = \frac{1}{2} \text{ rate}(\text{H}_2\text{O}_2)$ $= \frac{1}{2} (2,1 \times 10^{-3}) \checkmark \text{(c)}$ $= 1,05 \times 10^{-3}$ $\text{rate/tempo} = \frac{\Delta n}{\Delta t}$ $1,05 \times 10^{-3} = \frac{\checkmark \text{(d)} 0,028}{\Delta t}$ $\Delta t = 26,67 \text{ (s)} \checkmark \text{(e)}$	OPTION 4/OPSIE 4 $\text{rate H}_2\text{O}_2 = 2,1 \times 10^{-3} \text{ mol} \cdot \text{s}^{-1}$ $\text{Rate}(\text{O}_2) = \frac{1}{2} \text{ rate}(\text{H}_2\text{O}_2)$ $= \frac{1}{2} (2,1 \times 10^{-3}) \checkmark \text{(c)}$ $= 1,05 \times 10^{-3}$ In one second: $n(\text{O}_2) = \frac{m}{M}$ $1,05 \times 10^{-3} = \frac{m}{32} \checkmark \text{(b)}$ $m(\text{O}_2) = 0,0336 \text{ g}$ $\text{rate} = 0,0336 \text{ g} \cdot \text{s}^{-1}$ $\text{rate} = \frac{\Delta m}{\Delta t}$ $0,0336 = \frac{\checkmark \text{(d)} 0,9 - 0}{\Delta t} \checkmark \text{(a)}$ $\Delta t = 26,79 \text{ (s)} \checkmark \text{(e)}$

(5)
[19]

QUESTION 6/VRAAG 6

6.1

Marking criteria/Nasienkriteria

If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will cancel/oppose the disturbance. ✓✓

Wanneer die ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n nuwe ewewig instel deur die reaksie te bevoordeel wat die versteuring kanselleer/teenwerk.

(2)

6.2

$$K_c = \frac{[CS_2]}{[S]^2} \checkmark$$

$$9,4 = \frac{0,5}{[S]^2} \checkmark$$

$$[S] = 0,23 \text{ mol} \cdot \text{dm}^{-3} \checkmark$$

NOTE/LET WEL

- Wrong K_c expression/Verkeerde K_c -uitdrukking: Max./Maks. $\frac{2}{4}$
- No K_c expression but correct substitution/Geen K_c -uitdrukking but korrekte vervanging: Max/Maks. $\frac{3}{4}$

(4)

6.3

Increases/Neem toe ✓

(1)

6.4

- Increasing/doubling the volume will decrease the pressure. ✓
- The reaction that produces a greater number of moles/amount of gas (1 mole gas to 2 moles gas) is favoured. ✓
- Reverse reaction is favoured. ✓
- *Verhoging/verdubbeling van volume sal die druk verlaag.*
- *Die reaksie wat 'n groter aantal mol/hoeveelheid gas (1 mol gas na 2 mol gas) lewer word bevoordeel.*
- *Terugwaartse reaksie word bevoordeel.*

(3)

CALCULATIONS USING CONCENTRATION**BEREKENINGE WAT KONSENTRASIE GEBRUIK****Marking criteria:**

- (a) Initial concentration is halved. ✓
 (b) Change in $[CS_2]$ and $[S]$ **USING** ratio: $S : CS_2 = 2 : 1$ ✓
 (c) Equilibrium $[S] = \text{initial } [S] + \text{change in } [S]$ ✓
 (d) Equilibrium $[CS_2] = \text{initial } [CS_2] - \text{change in } [CS_2]$ ✓
 (e) **CORRECT** final answer. ✓

Nasienkriteria:

- (a) Aanvanklike konsentrasie is gehalveer. ✓
 (b) Verandering in $[CS_2]$ en $[S]$ deur **GEBRUIK** van verhouding $S : CS_2 = 2 : 1$ ✓
 (c) Ewewig $[S] = \text{aanvanklike } [S] + \text{verandering in } [S]$ ✓
 (d) Ewewig $[CS_2] = \text{aanvanklike } [CS_2] - \text{verandering in } [CS_2]$ ✓
 (e) **KORREKTE** finale antwoord. ✓

OPTION 1/OPSIE 1

	S	CS_2	
Initial concentration ($\text{mol} \cdot \text{dm}^{-3}$) Aanvangskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	$0,23 \times \frac{1}{2}$ $= 0,115$	$0,5 \times \frac{1}{2}$ $= 0,25$	✓ (a)
Change in concentration ($\text{mol} \cdot \text{dm}^{-3}$) Verandering in konsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	$2x$	x	✓ (b)
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$) Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	$0,115 + 2x$	$0,25 - x$	
	✓ (c)	✓ (d)	

$$K_c = \frac{[CS_2]}{[S]^2}$$

$$9,4 = \frac{0,25 - x}{(0,115 + 2x)^2} \quad \checkmark (e)$$

Wrong K_c expressionVerkeerde K_c - uitdrukking: Max./Maks. $\frac{4}{5}$

CALCULATIONS USING NUMBER OF MOLES

BEREKENINGE WAT GETAL MOL GEBRUIK

Marking criteria:

- (a) $n(\text{initial}) = c(\text{initial}) \times 2$. ✓
- (b) Change in $n(\text{S})$ and $n(\text{CS}_2)$ **USING** ratio: $\text{S} : \text{CS}_2 = 2 : 1$ ✓
- (c) Equilibrium $n(\text{S}) = \text{initial } n(\text{S}) + \text{change in } n(\text{S})$ ✓
- (d) Equilibrium $n(\text{CS}_2) = \text{initial } n(\text{CS}_2) - \text{change in } n(\text{CS}_2)$ ✓
- (e) **CORRECT** final answer. ✓

Nasienkriteria:

- (a) $n(\text{aanvanklik}) = c(\text{aanvanklik}) \times 2$ ✓
- (b) Verandering in $n(\text{S})$ en $n(\text{CS}_2)$ deur **GEBRUIK** van verhouding: $\text{S} : \text{CS}_2 = 2 : 1$ ✓
- (c) Ewewig $n(\text{S}) = \text{aanvanklike } n(\text{S}) + \text{verandering in } n(\text{S})$ ✓
- (d) Ewewig $n(\text{CS}_2) = \text{aanvanklike } n(\text{CS}_2) - \text{verandering in } n(\text{CS}_2)$ ✓
- (e) **KORREKTE** finale antwoord. ✓

OPTION 2/OPSIE 2

	S	CS ₂	
Initial quantity (mol) Aanvangshoeveelheid (mol)	0,46	1	✓ (a)
Change (mol) Verandering (mol)	8x	4x	✓ (b)
Quantity at equilibrium (mol)/ Hoeveelheid by ewewig (mol) ✓ (c)	0,46 + 8x	1 - 4x	✓ (d)
Equilibrium concentration (mol·dm ⁻³) Ewewigskonsentrasie (mol·dm ⁻³)	$\frac{0,46 + 8x}{4}$	$\frac{1 - 4x}{4}$	

$$K_c = \frac{[\text{CS}_2]}{[\text{S}]^2}$$

$$9,4 = \frac{\frac{1 - 4x}{4}}{\left(\frac{0,46 + 8x}{4}\right)^2} \quad \checkmark (e)$$

Wrong K_c expression

Verkeerde K_c -uitdrukking: Max./Maks. 4/5

(5)

6.6

- 6.6.1 (Chemical) equilibrium / Rate of the forward and reverse reactions are equal. / Concentrations of reactants and products are constant. ✓

(Chemiese) ewewig / Tempo van voorwaartse en terugwaartse reaksie dieselfde./Konsentrasies van reaktante en produkte is konstant.

(1)

- 6.6.2 Increase in the amount/concentration of S/reactant **OR** S was added. ✓
Toename in die hoeveelheid/konsentrasie S/reaktans **OF** S is bygevoeg.

(1)

- 6.6.3 Decrease in temperature/Verlaging in temperatuur ✓

(1)

- 6.6.4
- The rates of the forward and reverse reactions decrease. ✓
 - The reverse reaction is favoured / faster than the forward reaction.
 - OR**
 - The forward reaction decreases more. ✓
 - A decrease in temperature favours the exothermic reaction. ✓
 - Die voorwaartse en terugwaartse reaksietempo neem af.
 - Die terugwaartse reaksie word bevoordeel/is vinniger as die voorwaartse reaksie.
 - OF**
 - Die voorwaartse reaksie neem meer af.
 - 'n Verlaging in die temperatuur bevoordeel die eksotermiese reaksie.

(3)

[21]

QUESTION 5/VRAAG 5

- 5.1 B ✓
- The catalyst provides an alternative route of lower activation energy. ✓
 - More molecules have enough/sufficient (kinetic) energy./More molecules have (kinetic) energy equal to or higher than the activation energy. ✓
 - More effective collisions per unit time./Higher frequency of effective collisions. ✓
 - *Die katalisator verskaf 'n alternatiewe roete van laer aktiveringsenergie.*
 - *Meer molekule het genoeg/voldoende (kinetiese) energie./Meer molekule het (kinetiese) energie gelyk aan of groter hoër as die aktiveringsenergie.*
 - *Meer effektiewe botsings per eenheidtyd./Hoër frekwensie van effektiewe botsings.*
- (4)

5.2 Y ✓✓ (2)

5.3 560 (cm³) / 0,56 dm³ ✓✓ (2)

5.3.2 **POSITIVE MARKING FROM QUESTION 5.3.1.**
POSITIEWE NASIEN VANAF VRAAG 5.3.1.

<u>Marking criteria:</u> (a) Substitute <u>24 000 and 560/24 and 0,56</u> $\text{in } n = \frac{V}{V_m} \checkmark$ (b) USE mol ratio: $n(\text{H}_2\text{O}) : n(\text{O}_2) = 2 : 1 \checkmark$ (c) Substitute <u>18 and $n(\text{H}_2\text{O})$</u> in $m = nM \checkmark$ (d) Final answer: <u>0,83 g</u> ✓ Range: 0,72 to 0,9 g	<u>Nasienkriteria:</u> (a) Vervang <u>24 000 en 560/24 en 0,56</u> $\text{in } n = \frac{V}{V_m} \checkmark$ (b) <u>GEBRUIK</u> molverhouding: $n(\text{H}_2\text{O}) : n(\text{O}_2) = 2 : 1 \checkmark$ (c) Vervang <u>18 en $n(\text{H}_2\text{O})$</u> in $m = nM \checkmark$ (d) Finale antwoord: <u>0,83 g</u> ✓ Gebied: 0,72 tot 0,9 g
<u>OPTION 1/OPSIE 1</u> $n(\text{O}_2) = \frac{V}{V_m}$ $= \frac{560}{24\,000} \checkmark \text{(a)}$ $= 0,023 \text{ mol (0,0233)}$ $n(\text{H}_2\text{O}) = 2n(\text{O}_2)$ $n(\text{H}_2\text{O}) = 2(0,023) \checkmark \text{(b)}$ $= 0,046 \text{ mol (0,0467)}$ $m = nM$ $= 0,046 \times 18 \checkmark \text{(c)}$ $= 0,83 \text{ g} \checkmark \text{(d)}$	<u>OPTION 2/OPSIE 2</u> $\left. \begin{array}{l} 1 \text{ mol} \dots\dots\dots 24\,000 \text{ cm}^3 \\ x \text{ mol} \dots\dots\dots 560 \text{ cm}^3 \end{array} \right\} \checkmark \text{(a)}$ $x = 0,023 \text{ mol (0,0233)}$ $n(\text{H}_2\text{O}) = 2n(\text{O}_2)$ $n(\text{H}_2\text{O}) = 2(0,023) \checkmark \text{(b)}$ $= 0,046 \text{ mol (0,0467)}$ $m = nM$ $= 0,0466 \times 18 \checkmark \text{(c)}$ $= 0,83 \text{ g} \checkmark \text{(d)}$

(4)

- 5.4 0 (g·s⁻¹) / zero / nul ✓ (1)
- 5.4.1 Greater than/Groter as ✓ (1)

Marking criteria a) Substitute 0,9 g in $\frac{m}{M}$ ✓ b) Substitute 32 in $\frac{m}{M}$ ✓ c) USE mol /rate ratio: $n(\text{H}_2\text{O}_2) : n(\text{O}_2) = 2 : 1$ ✓ d) Substitute $2,1 \times 10^{-3}$ and $n(\text{H}_2\text{O}_2)$ in rate formula ✓ OR: Substitute <u>rate O₂</u> ($1,05 \times 10^{-3}$) and <u>$n(\text{O}_2)$</u> in rate formula OR: Substitute rate O₂ ($0,0336 \text{ g} \cdot \text{s}^{-1}$) in rate formula e) Final correct answer: 26,67 (s) ✓ Range: 26,67 to 28,57 (s)	Nasienkriteria: a) Vervang 0,9 g in $\frac{m}{M}$ ✓ b) Vervang 32 in $\frac{m}{M}$ ✓ c) <i>GEbruik mol-/tempoverhouding:</i> $n(\text{H}_2\text{O}_2) : n(\text{O}_2) = 2 : 1$ ✓ d) Vervang $2,1 \times 10^{-3}$ en $n(\text{H}_2\text{O}_2)$ in tempoformule ✓ OF: Vervang <u>tempo O₂</u> ($1,05 \times 10^{-3}$) en <u>$n(\text{O}_2)$</u> in tempoformule OF: Vervang tempo O₂ ($0,0336 \text{ g} \cdot \text{s}^{-1}$) in tempoformule e) Finale korrekte antwoord: 26,67 (s) ✓ Gebied: 26,67 tot 28,57 (s)
OPTION 1/OPSIE 1 $n(\text{O}_2) = \frac{m}{M}$ $= \frac{0,9}{32} \checkmark \text{(a)}$ $= 0,028 \text{ mol (0,0281)}$ $n(\text{H}_2\text{O}_2) = 2n(\text{O}_2)$ $= 2(0,028) \checkmark \text{(c)}$ $= 0,056$ $\text{rate/tempo} = \frac{\Delta n}{\Delta t}$ $2,1 \times 10^{-3} = \frac{\checkmark \text{(d)} 0,056 - 0}{\Delta t}$ $\Delta t = 26,67 \text{ (s)} \checkmark \text{(e)}$	OPTION 2/OPSIE 2 1 mol 32 g ✓(b) x mol 0,9 g ✓(a) $x = 0,0275 \text{ mol}$ $n(\text{H}_2\text{O}_2) = 2n(\text{O}_2)$ $= 2(0,0275) \checkmark \text{(c)}$ $= 0,056 \text{ mol}$ $\text{rate/tempo} = \frac{\Delta n}{\Delta t}$ $2,1 \times 10^{-3} = \frac{\checkmark \text{(d)} 0,056 - 0}{\Delta t}$ $\Delta t = 26,67 \text{ (s)} \checkmark \text{(e)}$
OPTION 3/OPSIE 3 $n(\text{O}_2) = \frac{m}{M}$ $= \frac{0,9}{32} \checkmark \text{(a)}$ $= 0,028 \text{ mol (0,0281)}$ $\text{Rate}(\text{O}_2) = \frac{1}{2} \text{rate}(\text{H}_2\text{O}_2)$ $= \frac{1}{2} (2,1 \times 10^{-3}) \checkmark \text{(c)}$ $= 1,05 \times 10^{-3}$ $\text{rate/tempo} = \frac{\Delta n}{\Delta t}$ $1,05 \times 10^{-3} = \frac{\checkmark \text{(d)} 0,028}{\Delta t}$ $\Delta t = 26,67 \text{ (s)} \checkmark \text{(e)}$	OPTION 4/OPSIE 4 $\text{rate H}_2\text{O}_2 = 2,1 \times 10^{-3} \text{ mol} \cdot \text{s}^{-1}$ $\text{Rate}(\text{O}_2) = \frac{1}{2} \text{rate}(\text{H}_2\text{O}_2)$ $= \frac{1}{2} (2,1 \times 10^{-3}) \checkmark \text{(c)}$ $= 1,05 \times 10^{-3}$ In one second: $n(\text{O}_2) = \frac{m}{M}$ $1,05 \times 10^{-3} = \frac{m}{32} \checkmark \text{(b)}$ $m(\text{O}_2) = 0,0336 \text{ g}$ $\text{rate} = 0,0336 \text{ g} \cdot \text{s}^{-1}$ $\text{rate} = \frac{\Delta m}{\Delta t}$ $0,0336 = \frac{\checkmark \text{(d)} 0,9 - 0}{\Delta t} \checkmark \text{(a)}$ $\Delta t = 26,79 \text{ (s)} \checkmark \text{(e)}$

(5)
[19]

QUESTION 6/VRAAG 6

6.1

Marking criteria/Nasienkriteria

If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

When the equilibrium in a closed system is disturbed, the system will re-instate a new equilibrium by favouring the reaction that will cancel/oppose the disturbance. ✓✓

Wanneer die ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n nuwe ewewig instel deur die reaksie te bevoordeel wat die versteuring kanselleer/teenwerk.

(2)

6.2

$$K_c = \frac{[CS_2]}{[S]^2} \checkmark$$

$$9,4 = \frac{0,5}{[S]^2} \checkmark$$

$$[S] = 0,23 \text{ mol} \cdot \text{dm}^{-3} \checkmark$$

NOTE/LET WEL

- Wrong K_c expression/Verkeerde K_c -uitdrukking: Max./Maks. $\frac{2}{4}$
- No K_c expression but correct substitution/Geen K_c -uitdrukking but korrekte vervanging: Max./Maks. $\frac{3}{4}$

(4)

6.3

Increases/Neem toe ✓

(1)

6.4

- Increasing/doubling the volume will decrease the pressure. ✓
- The reaction that produces a greater number of moles/amount of gas (1 mole gas to 2 moles gas) is favoured. ✓
- Reverse reaction is favoured. ✓
- *Verhoging/verdubbeling van volume sal die druk verlaag.*
- *Die reaksie wat 'n groter aantal mol/hoeveelheid gas (1 mol gas na 2 mol gas) lewer word bevoordeel.*
- *Terugwaartse reaksie word bevoordeel.*

(3)

CALCULATIONS USING CONCENTRATION**BEREKENINGE WAT KONSENTRASIE GEBRUIK****Marking criteria:**

- (a) Initial concentration is halved. ✓
 (b) Change in $[CS_2]$ and $[S]$ **USING** ratio: $S : CS_2 = 2 : 1$ ✓
 (c) Equilibrium $[S] = \text{initial } [S] + \text{change in } [S]$ ✓
 (d) Equilibrium $[CS_2] = \text{initial } [CS_2] - \text{change in } [CS_2]$ ✓
 (e) **CORRECT** final answer. ✓

Nasienkriteria:

- (a) Aanvanklike konsentrasie is gehalveer. ✓
 (b) Verandering in $[CS_2]$ en $[S]$ deur **GEBRUIK** van verhouding $S : CS_2 = 2 : 1$ ✓
 (c) Ewewig $[S] = \text{aanvanklike } [S] + \text{verandering in } [S]$ ✓
 (d) Ewewig $[CS_2] = \text{aanvanklike } [CS_2] - \text{verandering in } [CS_2]$ ✓
 (e) **KORREKTE** finale antwoord. ✓

OPTION 1/OPSIE 1

	S	CS_2	
Initial concentration ($\text{mol} \cdot \text{dm}^{-3}$) Aanvangskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	$0,23 \times \frac{1}{2}$ $= 0,115$	$0,5 \times \frac{1}{2}$ $= 0,25$	✓(a)
Change in concentration ($\text{mol} \cdot \text{dm}^{-3}$) Verandering in konsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	2x	x	✓(b)
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$) Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)	$0,115 + 2x$ ✓(c)	$0,25 - x$ ✓(d)	

$$K_c = \frac{[CS_2]}{[S]^2}$$

$$9,4 = \frac{0,25 - x}{(0,115 + 2x)^2} \quad \checkmark(e)$$

Wrong K_c expressionVerkeerde K_c - uitdrukking: Max./Maks. 4/5

CALCULATIONS USING NUMBER OF MOLES**BEREKENINGE WAT GETAL MOL GEBRUIK****Marking criteria:**

- (a) $n(\text{initial}) = c(\text{initial}) \times 2$. ✓
 (b) Change in $n(\text{S})$ and $n(\text{CS}_2)$ **USING** ratio: $\text{S} : \text{CS}_2 = 2 : 1$ ✓
 (c) Equilibrium $n(\text{S}) = \text{initial } n(\text{S}) + \text{change in } n(\text{S})$ ✓
 (d) Equilibrium $n(\text{CS}_2) = \text{initial } n(\text{CS}_2) - \text{change in } n(\text{CS}_2)$ ✓
 (e) **CORRECT** final answer. ✓

Nasienkriteria:

- (a) $n(\text{aanvanklik}) = c(\text{aanvanklik}) \times 2$ ✓
 (b) Verandering in $n(\text{S})$ en $n(\text{CS}_2)$ deur **GEBRUIK** van verhouding: $\text{S} : \text{CS}_2 = 2 : 1$ ✓
 (c) Ewewig $n(\text{S}) = \text{aanvanklike } n(\text{S}) + \text{verandering in } n(\text{S})$ ✓
 (d) Ewewig $n(\text{CS}_2) = \text{aanvanklike } n(\text{CS}_2) - \text{verandering in } n(\text{CS}_2)$ ✓
 (e) **KORREKTE** finale antwoord. ✓

OPTION 2/OPSIE 2

	S	CS ₂	
Initial quantity (mol) Aanvangshoeveelheid (mol)	0,46	1	✓(a)
Change (mol) Verandering (mol)	8x	4x	✓(b)
Quantity at equilibrium (mol)/ Hoeveelheid by ewewig (mol)	0,46 + 8x	1 - 4x	✓(c) ✓(d)
Equilibrium concentration (mol·dm ⁻³) Ewewigskonsentrasie (mol·dm ⁻³)	$\frac{0,46 + 8x}{4}$	$\frac{1 - 4x}{4}$	

$$K_c = \frac{[\text{CS}_2]}{[\text{S}]^2}$$

$$9,4 = \frac{\frac{1 - 4x}{4}}{\left(\frac{0,46 + 8x}{4}\right)^2} \quad \checkmark (e)$$

Wrong K_c expressionVerkeerde K_c -uitdrukking: Max./Maks. 4/5

(5)

- 6.6
- 6.6.1 (Chemical) equilibrium / Rate of the forward and reverse reactions are equal. / Concentrations of reactants and products are constant. ✓
 (Chemiese) ewewig / Tempo van voorwaartse en terugwaartse reaksie dieselfde./Konsentrasies van reaktante en produkte is konstant. (1)
- 6.6.2 Increase in the amount/concentration of S/reactant **OR** S was added. ✓
 Toename in die hoeveelheid/konsentrasie S/reaktans **OF** S is bygevoeg. (1)
- 6.6.3 Decrease in temperature/Verlaging in temperatuur ✓ (1)
- 6.6.4
- The rates of the forward and reverse reactions decrease. ✓
 - The reverse reaction is favoured / faster than the forward reaction.
- OR**
- The forward reaction decreases more. ✓
 - A decrease in temperature favours the exothermic reaction. ✓
 - Die voorwaartse en terugwaartse reaksietempo neem af.
 - Die terugwaartse reaksie word bevoordeel/is vinniger as die voorwaartse reaksie.
- OF**
- Die voorwaartse reaksie neem meer af.
 - 'n Verlaging in die temperatuur bevoordeel die eksotermiese reaksie. (3)
- [21]

QUESTION/VRAAG 5

5.1 Initial concentration is 0 (of NO_2)./Concentration increases./

Curve starts at 0. ✓

Beginkonsentrasie is 0 (van NO_2)./Konsentrasie verhoog./Kurwe begin by 0.

OR/OF

Curve B has an initial concentration and is the reactant as its concentration decreases.

Kurwe B het 'n beginkonsentrasie en is die reaktant aangesien sy konsentrasie afneem.

(1)

5.2 True/Waar ✓

n mol of N_2O_5 forms $2n$ mol of NO_2 per unit time. ✓

n mol N_2O_5 vorm $2n$ mol NO_2 per eenheidstyd.

OR/OF

Gradient of graph for NO_2 is twice the gradient of graph for N_2O_5 .

Gradiënt van grafiek vir NO_2 is twee keer die gradiënt van grafiek vir N_2O_5 .

NOTE/LET WEL:

If gradients calculated correctly award mark.

Indien gradiënte korrek bereken word punt toegeken.

(2)

5.3.1

Marking criteria/Nasienkriteria:

- Formula: $c = \frac{m}{MV}$ / $n(\text{NO}_2) = cV$ / $n(\text{NO}_2) = \frac{m}{M}$ ✓
- Substitute change in concentration. ✓
Vervang verandering in konsentrasie.
- Substitute M (46) and V (2). / *Vervang M (46) en V (2).* ✓
- Final correct answer/ *Finale korrekte antwoord:* 1,84 g ✓

OPTION 1/OPSIE 1

$$c(\text{NO}_2) = \frac{m}{MV} \quad \checkmark$$

$$200 \times 10^{-4} \checkmark = \frac{m}{(46)(2) \checkmark}$$

$$m = 1,84 \text{ g} \quad \checkmark$$

OPTION 2/OPSIE 2

$n(\text{NO}_2) = cV \checkmark$
 $= (200 \times 10^{-4}) \checkmark \times 2$
 $= 4 \times 10^{-2} \text{ mol}$
 $n(\text{NO}_2) = \frac{m}{M}$
 $4 \times 10^{-2} = \frac{m}{46}$
 $m = 1,84 \text{ g} \quad \checkmark$

✓ either/
 enige
 een

✓ both/
 beide

(4)

5.3.2

Marking criteria/Nasienkriteria:

- Substitute the change in concentration into rate formula. ✓
Vervang verandering in konsentrasie in tempo formule.
- Substitute time into the rate formula. / *Vervang tyd in tempo formule.* ✓
- Use mol ratio/ *Gebruik molverhouding:* $\text{rate/tempo}(\text{O}_2) = \frac{1}{2} \text{rate/tempo}(\text{N}_2\text{O}_5)$ /
 $\text{rate/tempo}(\text{O}_2) = \frac{1}{4} \text{rate/tempo}(\text{NO}_2)$ ✓
- Final correct answer/ *Finale korrekte antwoord:* $1 \times 10^{-5} (\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1})$ ✓

NOTE/LET WEL

If concentration is converted to moles, final moles per s ($\text{mol} \cdot \text{s}^{-1}$) must be converted back to concentration ($\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}$). i.e. there must be multiplication and division by 2. If one of these is omitted:

Max. $\frac{2}{4}$

Indien konsentrasie omgeskakel is na mol, moet die finale mol per s ($\text{mol} \cdot \text{s}^{-1}$) omgeskakel word na konsentrasie ($\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}$) d.w.s daar moet vermenigvuldig en gedeel word deur 2. Indien een van hierdie uitgelaat word:

Maks. $\frac{2}{4}$ **OPTION 1/OPSIE 1**

$$\text{Ave rate/gem tempo} = - \frac{\Delta c(\text{N}_2\text{O}_5)}{\Delta t}$$

$$= - \frac{(60 \times 10^{-4} - 200 \times 10^{-4}) \checkmark}{700 (-0) \checkmark}$$

$$= 2 \times 10^{-5} (\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1})$$

$$\text{rate}(\text{O}_2) = \frac{1}{2} \text{rate}(\text{N}_2\text{O}_5) = \frac{1}{2}(2 \times 10^{-5}) \checkmark$$

$$= 1 \times 10^{-5} (\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}) \quad \checkmark$$

OPTION 2/OPSIE 2

$$\text{Ave rate/gem tempo} = \frac{\Delta c(\text{NO}_2)}{\Delta t}$$

$$= \frac{(280 \times 10^{-4} (-0)) \checkmark}{700 (-0) \checkmark}$$

$$= 4 \times 10^{-5} (\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1})$$

$$\text{rate}(\text{O}_2) = \frac{1}{4} \text{rate}(\text{NO}_2) = \frac{1}{4}(4 \times 10^{-5}) \checkmark$$

$$= 1 \times 10^{-5} (\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}) \quad \checkmark$$

OPTION 3/OPSIE 3

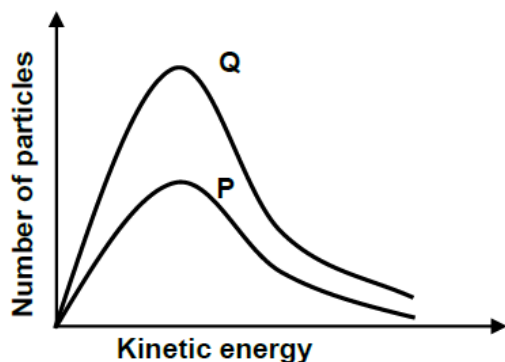
$$\begin{aligned}\Delta c(\text{O}_2) &= \frac{1}{2} \Delta c(\text{N}_2\text{O}_5) \\ &= \frac{1}{2} (60 \times 10^{-4} - 200 \times 10^{-4}) \checkmark \\ &= \frac{1}{2} (140 \times 10^{-4}) \\ &= 7 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3}\end{aligned}$$

OR/OF

$$\begin{aligned}\Delta c(\text{O}_2) &= \frac{1}{4} \Delta c(\text{NO}_2) \\ &= \frac{1}{4} (280 \times 10^{-4} - 0) \checkmark \\ &= 7 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3} \\ &= 7 \times 10^{-3} \text{ mol} \cdot \text{dm}^{-3}\end{aligned}$$

$$\begin{aligned}\text{Ave rate/gem tempo} &= \frac{\Delta c(\text{O}_2)}{\Delta t} \\ &= \frac{(7 \times 10^{-3})}{700 (-0)} \checkmark \\ &= 1 \times 10^{-5} (\text{mol} \cdot \text{dm}^{-3} \cdot \text{s}^{-1}) \checkmark\end{aligned}$$

(4)

5.4
5.4.1**Marking criteria/Nasienkriteria**

- Curve Q must be above the given curve P and have the same shape as the given curve P and the peaks have to correspond. ✓

Kurwe Q moet bo die gegewe kurwe P wees en moet dieselfde vorm hê as die gegewe kurwe P en die maksimums moet ooreenstem

- Starts at origin and not crossing curve P. ✓
Begin by oorsprong en nie kruis met kurwe P nie.

(2)

5.4.2 Higher than/Hoër as ✓

- When the concentration of N_2O_5 is higher there are more N_2O_5 particles per unit volume. ✓
- More effective collisions per unit time/second. ✓

OR

Higher frequency of effective collisions.

- 'n Hoër konsentrasie van N_2O_5 bevat meer N_2O_5 -deeltjies per eenheidsvolume. ✓
- Meer effektiewe botsings per eenheidstyd/sekonde. ✓

OF

Hoër frekwensie van effektiewe botsings.

(3)

[16]

QUESTION/VRAAG 6

6.1

Marking criteria/Nasienkriteria:

If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark. *Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.*

When the equilibrium in a closed system is disturbed, the system will re-instate a (new) equilibrium by favouring the reaction that will cancel/oppose the disturbance. ✓✓

Wanneer die ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n (nuwe) ewewig instel deur die reaksie te bevoordeel wat die versteuring kanselleer/teenwerk.

(2)

6.2

6.2.1 $n[\text{H}_2(\text{g})] = 0,11 \text{ (mol)}$ ✓

(1)

6.2.2

OPTION 1/OPSIE 1

$$\begin{aligned} n(\text{HI})_{\text{used/gebruik}} &= 2n(\text{I}_2) \\ &= 2(0,11) \\ n(\text{HI})_{\text{eq}} &= 1 - 0,22 \\ &= 0,78 \text{ (mol)} \quad \checkmark \end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned} K_c &= \frac{[\text{H}_2][\text{I}_2]}{[\text{HI}]^2} \\ 0,02 &= \frac{(0,11)(0,11)}{[\text{HI}]^2} \\ [\text{HI}] &= 0,78 \text{ mol} \cdot \text{dm}^{-3} \\ n(\text{HI}) &= 0,78 \text{ (mol)} \quad \checkmark \end{aligned}$$

(1)

6.3

6.3.1 Endothermic/Endotermies ✓

(1)

6.3.2 K_c increased:

- The concentration of the product/ $\text{H}_2(\text{g})$ and $\text{I}_2(\text{g})$ is increased. ✓
OR: The concentration of the reactant/HI decreases.
- The increase in temperature favours the forward reaction. ✓
- (According to Le Chatelier's principle) an increase in temperature favours the endothermic reaction. ✓

K_c het verhoog:

- Die konsentrasie van die produkte/ $\text{H}_2(\text{g})$ en $\text{I}_2(\text{g})$ verhoog. ✓
OF: Die konsentrasie van die reaktanse/HI verlaag.
- 'n Toename in temperatuur bevoordeel die voorwaartse reaksie. ✓
- (Volgens Le Chatelier se beginsel) sal 'n toename in temperatuur die endotermiese reaksie bevoordeel. ✓

(3)

POSITIVE MARKING FROM Q6.2/POSITIEWE NASIEN VANAF V6.2

Marking criteria:	Nasienkriteria:
(a) Correct K_c expression (formulae in square brackets). ✓	(a) Korrekte K_c uitdrukking (formules in vierkantige hakies). ✓
(b) Substitution of 0,09 in K_c expression. ✓	(b) Vervang 0,09 in K_c uitdrukking. ✓
(c) Correct initial moles from 6.2.1 and 6.2.2. ✓	(c) Aanvanklike mol korrek vanaf 6.2.1 en 6.2.2. ✓
(d) USING ratio: $n\text{HI(g)} : 2n\text{I}_2\text{(g)} = 1:2$ ✓	(d) GEBRUIK verhouding: $n\text{HI(g)} : 2n\text{I}_2\text{(g)} = 1:2$ ✓
(e) Substitution of concentrations into correct K_c expression. ✓	(e) Vervang konsentrasies in korrekte K_c uitdrukking. ✓
(f) Subtraction $[\text{HI}]_{\text{ini}} - \Delta[\text{HI}]$ ✓	(f) Verskil: $[\text{HI}]_{\text{aanv}} - \Delta[\text{HI}]$ ✓
(g) Substitution of 128 in $m = nM$. ✓	(g) Vervang 128 in $m = nM$. ✓
(h) Final answer: 80,64 g ✓ (range: 79,36 - 80,64 g)	(h) Finale antwoord: 80,64 g ✓ (gebied: 79,36 - 80,64 g)

OPTION 1/OPSIE 1

$$K_c = \frac{[\text{H}_2][\text{I}_2]}{[\text{HI}]^2} \quad \checkmark \text{ (a)} \quad \checkmark \text{ (c) (0,11 and/en 0,78 from 6.2.1 and/en 6.2.2)}$$

$$0,09 = \frac{(0,11 + x)(0,11 + x)}{(0,78 - 2x)^2} \quad \checkmark \text{ (e)}$$

$$x = 0,0775$$

$$[\text{HI}]_{\text{equilibrium/ewewig}} = [\text{HI}]_{\text{ini/aanv}} - \Delta[\text{HI}]$$

$$= 0,78 - 2(0,0775) \quad \checkmark \text{ (f)}$$

$$= 0,63 \text{ mol} \cdot \text{dm}^{-3} \quad (0,625)$$

$$n(\text{HI}) = cV$$

$$= (0,63)(1)$$

$$= 0,63 \text{ mol} \quad (0,625)$$

$$m(\text{HI}) = nM$$

$$= (0,63)(128) \quad \checkmark \text{ (g)}$$

$$= 80,64 \text{ g} \quad \checkmark \text{ (h)}$$

OR/OF

$$m(\text{HI}) = cVM$$

$$= (0,63)(1)(128) \quad \checkmark \text{ (g)}$$

$$= 80,64 \text{ g} \quad \checkmark \text{ (h)}$$

OPTION 2/OPSIE 2

	HI	I ₂	H ₂
Initial quantity (mol) <i>Aanvanklike hoeveelheid (mol)</i>	0,78	0,11	0,11
Change (mol) <i>Verandering (mol)</i>	2x	x	x
Quantity at equilibrium (mol) <i>Hoeveelheid by ewewig (mol)</i>	0,78 - 2x	0,11 + x	0,11 + x
Equilibrium concentration <i>Ewewigskonsentrasie</i> (mol·dm ⁻³)	$\frac{0,78 - 2x}{1}$	$\frac{0,11 + x}{1}$	$\frac{0,11 + x}{1}$

Ratio 1:2
✓

$$K_c = \frac{[H_2][I_2]}{[HI]^2} \quad \checkmark (a)$$

$$(b) \quad 0,09 = \frac{(0,11 + x)(0,11 + x)}{(0,78 - 2x)^2} \quad \checkmark (e)$$

$$x = 0,0775$$

$$[HI]_{\text{equilibrium/ewewig}} = \frac{0,78 - 2(0,0775)}{1} \quad \checkmark (f)$$

$$= 0,63 \text{ mol} \cdot \text{dm}^{-3} (0,625)$$

$$n(HI) = cV$$

$$= (0,63)(1)$$

$$= 0,63 \text{ mol } (0,625 \text{ mol})$$

$$m(HI) = nM$$

$$= (0,63)(128) \quad \checkmark (g)$$

$$= 80,64 \text{ g } \quad \checkmark (h)$$

OR/OF

$$m(HI) = cVM$$

$$= (0,63)(1)(128) \quad \checkmark (g)$$

$$= 80,64 \text{ g } \quad \checkmark (h)$$

(8)
[16]

QUESTION 5/VRAAG 5

5.1

NOTE/LET WELGive the mark for per unit time only if in context of reaction rate.Gee die punt vir per eenheidtyd slegs indien in konteks met reaksietempo.**ANY ONE:**

- Change in concentration ✓ of products/reactants per (unit) time. ✓
- Change in amount/number of moles/volume/mass of products or reactants per (unit) time.
- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time.
- Rate of change in concentration/amount/number of moles/volume/mass. ✓✓ (2 or 0)

ENIGE EEN:

- Verandering in konsentrasie van produkte/reaktanse per (eenheid) tyd.
- Verandering in hoeveelheid/getal mol/volume/massa van produkte of reaktanse per (eenheid) tyd.
- Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktanse gebruik per (eenheid) tyd.
- Tempo van verandering in konsentrasie/ hoeveelheid/getal mol/volume/massa. (2 of 0) (2)

5.2

- Surface area / state of division / particle size (of MgCO_3) ✓
- Concentration (of HCl) ✓
- *Reaksieoppervlak/toestand van verdeeldheid/deeltjie-grootte (van MgCO_3)*
- *Konsentrasie (van HCl)* (2)

5.3

- At a higher temperature particles move faster/have a higher kinetic energy. ✓
- More molecules have enough/sufficient kinetic energy for an effective collision. ✓
- OR More molecules have kinetic energy/ E_k equal to or greater than the activation energy.
- More effective collisions per unit time/second. ✓
- OR Frequency of effective collisions increases.
- Reaction rate increases. ✓
- *By 'n hoër temperatuur beweeg die deeltjies vinniger/het die deeltjies hoër kinetiese energie.* ✓
- Meer molekule het genoeg/voldoende kinetiese energie/ E_k vir 'n effektiewe botsing. ✓
- OF Meer molekule het kinetiese energie gelyk aan of groter as die aktiveringsenergie.
- Meer effektiewe botsings per eenheidtyd/sekonde. ✓
- OF Frekwensie van effektiewe botsings verhoog.
- *Reaksietempo neem toe.* ✓ (4)

5.4.1

<u>Marking criteria</u>	<u>Nasienkriteria</u>
- Formula: $n = \frac{m}{M}$ ✓ - Substitution of $84 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$ ✓ - Use mole ratio: $n(\text{MgCO}_3)_{\text{used}} = n(\text{CO}_2)_{\text{produced}}$ ✓ - Substitution of $44 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$ or to calculate rate in $\text{mol} \cdot \text{min}^{-1}$. ✓ - Correct substitution of 0,5 in rate equation. ✓ - Final answer: 5,238 to 5,28 min ✓	- Formule: $n = \frac{m}{M}$ ✓ - Vervanging van $84 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$ ✓ - Gebruik molverhouding: $n(\text{MgCO}_3)_{\text{gebruik}} = n(\text{CO}_2)_{\text{berei}}$ ✓ - Vervanging van $44 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$ of om tempo te bereken in $\text{mol} \cdot \text{min}^{-1}$. ✓ - Korrekte vervanging van 0,5 in tempovergelyking. ✓ - Finale antwoord: 5,238 tot 5,28 min ✓
$n(\text{MgCO}_3) = \frac{m}{M} \checkmark$ $= \frac{5}{84} \checkmark$ $= 0,06 \text{ mol } (0,0595 \text{ mol})$ $n(\text{CO}_2)_{\text{produced/gevorm}} = n(\text{MgCO}_3) \checkmark = 0,06 \text{ mol}$ $n(\text{CO}_2) = \frac{m}{M}$ $0,06 = \frac{m}{44} \checkmark$ $m(\text{CO}_2) = 2,64 \text{ g}$ $\text{Ave rate/gem tempo} = \frac{\Delta m(\text{CO}_2)}{\Delta t}$ $0,5 \checkmark = \frac{2,64}{\Delta t}$ $\Delta t = 5,28 \text{ min } \checkmark$ $\text{Ave rate/gem tempo in } \text{mol} \cdot \text{min}^{-1}:$ $\frac{0,5 \checkmark}{44 \checkmark} = 0,0114 \text{ mol} \cdot \text{min}^{-1}$ $\text{Ave rate/gem tempo} = \frac{\Delta n(\text{CO}_2)}{\Delta t}$ $0,0114 = \frac{0,06}{\Delta t}$ $\Delta t = 5,28 \text{ min } \checkmark$	

(6)

5.4.2

POSITIVE MARKING FROM QUESTION 5.4.1.**POSITIEWE NASIEN VANAF VRAAG 5.4.1.**

<u>Marking criteria</u>	<u>Nasienkriteria</u>
- Substitution of $n(\text{CO}_2)$ AND $1,5 \text{ dm}^3$ in $n = \frac{V}{V_m}$ ✓ - Final answer: 25 to $25,21 \text{ dm}^3 \cdot \text{mol}^{-1}$ ✓	- Vervanging van $n(\text{CO}_2)$ EN $1,5 \text{ dm}^3$ in $n = \frac{V}{V_m}$ ✓ - Finale antwoord: 25 dm^3 tot $25,21 \text{ dm}^3 \cdot \text{mol}^{-1}$ ✓

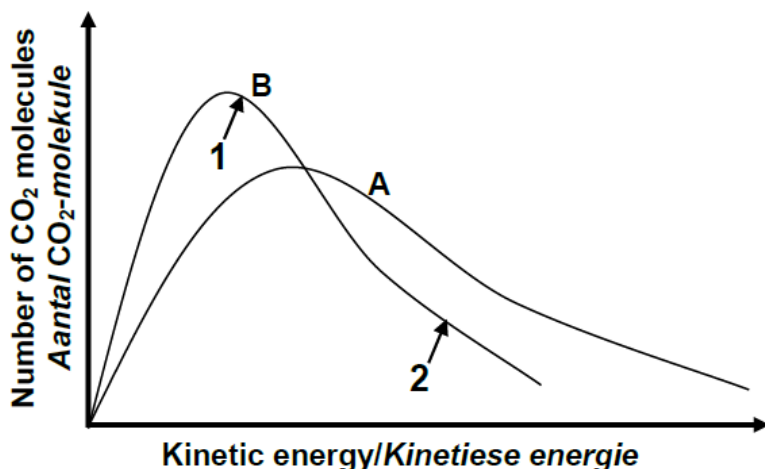
$$n = \frac{V}{V_m}$$

$$0,06 = \frac{1,5}{V_m} \checkmark$$

$$V_m = 25 \text{ dm}^3 \cdot \text{mol}^{-1} \checkmark \quad (25,21 \text{ dm}^3 \cdot \text{mol}^{-1})$$

ACCEPT/AANVAAR: 25 dm^3

(2)



Marking criteria/Nasienkriteria		
1	Curve B has a higher peak to the left of curve A. <i>Kurwe B het hoër piek aan die linkerkant van kurwe A.</i>	✓
2	Curve B is below curve A beyond the peak of curve A. <i>Kurwe B is onder kurwe A na die piek van kurwe A.</i>	✓
If BOTH graphs not labelled (A and B): no marks <i>Indien BEIDE grafieke nie benoem nie (A en B): geen punte</i>		

(2)
[18]

QUESTION 6/VRAAG 6

6.1.1 2 (mol·dm⁻³) ✓

(1)

6.1.2 **Marking criteria/Nasienkriteria:**

If any one of the underlined key phrases in the **correct context** is omitted, deduct 1 mark./Indien enige van die onderstreepte frases in die **korrekte konteks** uitgelaat is, trek 1 punt af.

When the equilibrium in a closed system is disturbed, the system will re-instate a (new) equilibrium ✓ by favouring the reaction that will cancel/oppose the disturbance. ✓

Wanneer die ewewig in 'n geslote sisteem versteur word, sal die sisteem 'n (nuwe) ewewig instel deur die reaksie te bevoordeel wat die versteuring kanselleer/teenwerk.

(2)

6.1.3 Cooled/Afgekoel ✓

(1)

- 6.1.4
- A decrease in temperature favours the exothermic reaction./An increase in temperature favours the endothermic reaction. ✓
 - The forward reaction is favoured./HI concentration increases./Equilibrium (position) shifts to the right. ✓
 - The forward reaction is exothermic./Reverse reaction is endothermic. ✓
 - *Afname in temperatuur bevoordeel die eksotermiese reaksie./Toename in temperatuur bevoordeel die endotermiese reaksie. ✓*
 - *Die voorwaartse reaksie word bevoordeel./ HI-konsentrasie neem toe./Die ewewigs(posisie) skuif na regs. ✓*
 - *Voorwaatse reaksie is eksotermies./Die terugwaartse reaksie is endotermies. ✓*

(3)

6.2
6.2.1

Products can be converted back to reactants. ✓
OR
Both forward and reverse reactions can take place.
OR
A reaction which can take place in both directions.

Produkke kan omgeskakel word na reaktanse. ✓

OF
Beide voor-en terugwaartse reaksies kan plaasvind.
OF
'n Reaksie wat in beide rigtings kan plaasvind.

(1)

6.2.2

<u>Marking criteria</u>	<u>Nasienkriteria:</u>
a) $\Delta n(\text{N}_2\text{O}_4) = n(\text{N}_2\text{O}_4)_{\text{eq}} - n(\text{N}_2\text{O}_4)_{\text{ini}}$. ✓	(a) $\Delta n(\text{N}_2\text{O}_4) = n(\text{N}_2\text{O}_4)_{\text{ewe}} - n(\text{N}_2\text{O}_4)_{\text{aanv}}$. ✓
b) <u>USING</u> ratio: $n(\text{NO}_2) : n(\text{N}_2\text{O}_4) = 2 : 1$ ✓	(b) <u>GEBRUIK</u> verhouding: $n(\text{NO}_2) : n(\text{N}_2\text{O}_4) = 2 : 1$ ✓
c) $n(\text{NO}_2)_{\text{eq}} = n(\text{NO}_2)_{\text{ini}} - \Delta n(\text{NO}_2)$ ✓	(c) $n(\text{NO}_2)_{\text{ewe}} = n(\text{NO}_2)_{\text{aanv}} - \Delta n(\text{NO}_2)$ ✓
d) Divide BOTH by 1 dm^3 ✓	(d) Deel BEIDE deur 1 dm^3 ✓
e) Correct K_c expression (<u>formulae in square brackets</u>). ✓	(e) Korrekte K_c uitdrukking (<u>formules in vierkantige hakies</u>). ✓

	NO_2	N_2O_4	ratio ✓ verhouding
Initial amount (moles) <i>Aanvangshoeveelheid (mol)</i>	x	0	
Change in amount (moles) <i>Verandering in hoeveelheid (mol)</i>	1,62	0,81 ^(a) ✓	
Equilibrium amount (moles) <i>Ewewigshoeveelheid (mol)</i>	$x - 1,62$ ^(c) ✓	0,81	
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$) <i>Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)</i>	$x - 1,62$	0,81	

$$K_c = \frac{[\text{N}_2\text{O}_4]}{[\text{NO}_2]^2} \quad \checkmark \text{ (e)}$$

$$= \frac{(0,81)}{(x - 1,62)^2}$$

Wrong or no K_c expression/Verkeerde of geen K_c -uitdrukking: Max./Maks. $\frac{4}{5}$

(5)

Marking criteria

- a) Add 0,79 mol to $n(\text{N}_2\text{O}_4)_{\text{ini}}$. ✓
 b) USING ratio: $n(\text{NO}_2) : n(\text{N}_2\text{O}_4) = 2 : 1$
 to calculate $\Delta n(\text{N}_2\text{O}_4)$ as 0,6 mol. ✓
 c) $n(\text{NO}_2)_{\text{eq}} = n(\text{NO}_2)_{\text{ini}} + \Delta n(\text{NO}_2)$
 $n(\text{N}_2\text{O}_4)_{\text{eq}} = n(\text{N}_2\text{O}_4)_{\text{ini}} - \Delta n(\text{N}_2\text{O}_4)$ } ✓
 d) Substitution of concentrations into
 correct K_c expression. ✓
 e) Equating K_c expression from Q6.1.3
 and Q6.2.3. ✓
 f) Final answer: 12,42 ✓
 (Range: 11,27 – 12,42)

Nasienkriteria:

- (a) Voeg 0,79 mol by $n(\text{N}_2\text{O}_4)_{\text{aanv}}$. ✓
 (b) GEBRUIK verhouding:
 $n(\text{NO}_2) : n(\text{N}_2\text{O}_4) = 2 : 1$
 om $\Delta n(\text{N}_2\text{O}_4)$ as 0,6 mol te bereken. ✓
 (c) $n(\text{NO}_2)_{\text{ewe}} = n(\text{NO}_2)_{\text{aanv}} + \Delta n(\text{NO}_2)$
 $n(\text{N}_2\text{O}_4)_{\text{ewe}} = n(\text{N}_2\text{O}_4)_{\text{aanv}} - \Delta n(\text{N}_2\text{O}_4)$ } ✓
 (d) Vervanging van konsentrasies in
 korrekte K_c -uitdrukking.
 (e) Stel K_c -uitdrukking van Q6.1.3 en
 Q6.2.3 gelyk aan mekaar. ✓
 (f) Finale antwoord: 12,42 ✓
 (Gebied: 11,27 – 12,42)

	NO_2	N_2O_4
Initial amount (moles) <i>Aanvangs hoeveelheid (mol)</i>	$x - 1,62$	$0,81 + 0,79$ ✓ $= 1,6$
Change in amount (moles) <i>Verandering in hoeveelheid (mol)</i>	1,2	0,6 ✓
Equilibrium amount (moles) <i>Ewewigshoeveelheid (mol)</i>	$x - 1,62 + 1,2$	1 ✓ (c)
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$) <i>Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)</i>	$x - 0,42$	1

$$K_c = \frac{[\text{N}_2\text{O}_4]}{[\text{NO}_2]^2}$$

$$\frac{(0,81)}{(x - 1,62)^2} \stackrel{(e)}{=} \frac{1}{(x - 0,42)^2} \stackrel{(d)}{=} \quad \checkmark$$

$$x = 12,42 \text{ (mol)} \quad \checkmark (f)$$

Wrong K_c expression/Verkeerde K_c - uitdrukking:Max./Maks. $\frac{4}{6}$ No K_c expression/Geen K_c - uitdrukking: $\frac{6}{6}$

(6)

[19]

QUESTION 5/VRAAG 5

5.1

NOTE/LET WEL

Give the mark for per unit time only if in context of reaction rate.

Gee die punt vir per eenheidtyd slegs indien in konteks met reaksietempo.

ANY ONE/ENIGE EEN

- Change in concentration ✓ of products/reactants per (unit) time. ✓
Verandering in konsentrasie van produkte/reaktanse per (eenheid)tyd.
- Change in amount/number of moles/volume/mass of products or reactants per (unit) time.
Verandering in hoeveelheid/getal mol/volume/massa van produkte of reaktanse per (eenheid)tyd.
- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time.
Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktanse gebruik per (eenheid)tyd.
- Rate of change in concentration/amount/number of moles/volume/mass.
Tempo van verandering in konsentrasie/ hoeveelheid/getal mol/ volume/ massa. ✓✓ (2 or/of 0)

(2)

5.2

- Time/tyd ✓
- Volume of gas/CO₂/carbon dioxide (in gas syringe)✓
Volume gas/CO₂/koolstofdioksied (in gasspuit)

OR/OF

- Time taken for Al₂(CO₃)₃ to be used up. ✓✓
Tyd geneem vir die Al₂(CO₃)₃ om opgebruik te word.

Accept/Aanvaar

Measure volume of gas/CO₂ at regular time intervals. ✓✓

Meet volume van gas/CO₂ met gereelde tydintervalle.

(2)

5.3

Experiment II/Eksperiment II:

- More (HCl) particles per unit volume./More particles with correct orientation. ✓
- More effective collisions per unit time./Higher frequency of effective collisions. ✓
- Higher reaction rate. ✓
- Meer (HCl)-deeltjies per eenheid volume./Meer deeltjies met korrekte oriëntasie.
- Meer effektiewe botsings per eenheid tyd./Hoër frekwensie van effektiewe botsings.
- *Hoër reaksietempo.*

(3)

OR/OF

Experiment 1/Eksperiment 1:

- Less (HCl) particles per unit volume. ✓
- Less effective collisions per unit time./Lower frequency of effective collisions. ✓
- Lower reaction rate. ✓
- Minder (HCl) deeltjies per eenheidvolume.
- Minder effektiewe botsings per eenheidtyd./ Laer frekwensie van effektiewe botsings.
- Laer reaksietempo.

5.4

OPTION 1/OPSIE 1 ave rate/gem tempo = $-\frac{\Delta n}{\Delta t}$ $4,4 \times 10^{-3} = -\frac{n_f - 0,016}{2,5(-0)}$ ✓ $n[\text{Al}_2(\text{CO}_3)_3] = 0,005 \text{ (mol)}$ ✓	Marking criteria/Nasienkriteria • Substitute average rate and Δt./ Vervang gemiddelde tempo en Δt. ✓ • Substitute/Vervang Δn. ✓ • Final answer/Finale antwoord: 0,005 (mol) ✓
OPTION 2/OPSIE 2 ave rate/gem tempo = $\frac{\Delta n}{\Delta t}$ $4,4 \times 10^{-3} = \frac{\Delta n}{2,5}$ ✓ $\Delta n[\text{Al}_2(\text{CO}_3)_3] = 0,016 - 0,011$ ✓ $= 0,005 \text{ mol}$ ✓	NOTE/LET WEL • Accept negative answers when the negative sign in front of the formula is omitted./Aanvaar negatiewe antwoord wanneer die negatiewe teken voor die formule uitgelaat is. • Do not penalise if initial and final mole values or time values are swopped. / Moenie penaliseer indien aanvanklike en finale molwaardes omgeruil is nie.
OPTION 3/OPSIE 3 With reference to CO₂/Met verwysing na CO₂ ave. rate/gem tempo = $\frac{\Delta n}{\Delta t}$ $4,4 \times 10^{-3} = \frac{\Delta n}{2,5}$ ✓ $\Delta n(\text{CO}_2) = 0,011 \text{ mol}$ $n(\text{CO}_2) : n(\text{Al}_2(\text{CO}_3)_3)$ 3 : 1 0,011 : $3,67 \times 10^{-3} \text{ mol}$ ✓ $n(\text{Al}_2(\text{CO}_3)_3 \text{ left/oor}) = 0,016 - 3,67 \times 10^{-3} = 1,23 \times 10^{-2} \text{ mol}$ ✓	

OPTION 4/OPSIE 4**With reference to HCl/Met verwysing na HCl**

$$\text{ave. rate/gem tempo} = \frac{\Delta n}{\Delta t}$$

$$4,4 \times 10^{-3} = \frac{\Delta n}{2,5}$$

$$\Delta n(\text{HCl}) = 0,011 \text{ mol}$$

$$n[\text{Al}_2(\text{CO}_3)_3] = \frac{0,011}{6} = 0,0018 \text{ mol} \checkmark$$

$$n[\text{Al}_2(\text{CO}_3)_3] \text{ left/oor} = 0,016 - 0,0018 = 0,0142 \text{ mol} \checkmark$$

OPTION 5/OPSIE 5**With reference to AlCl₃/Met verwysing na AlCl₃**

$$\text{ave. rate/gem tempo} = \frac{\Delta n}{\Delta t}$$

$$4,4 \times 10^{-3} = \frac{\Delta n}{2,5}$$

$$\Delta n(\text{AlCl}_3) = 0,011 \text{ mol}$$

$$n[\text{Al}_2(\text{CO}_3)_3] = 0,0055 \text{ mol} \checkmark$$

$$n[\text{Al}_2(\text{CO}_3)_3] \text{ left/oor} = 0,016 - 0,0055 = 0,0105 \text{ mol} \checkmark$$

(3)

5.5

Marking criteria/Nasienkriteria:

- Use mol ratio/Gebruik molverhouding: $n(\text{CO}_2) : n[\text{Al}_2(\text{CO}_3)_3] = 3 : 1 \checkmark$

- Substitute $24\,000 \text{ cm}^3 \cdot \text{mol}^{-1} / 24 \text{ dm}^3 \cdot \text{mol}^{-1}$ in $n = \frac{V}{V_M}$ or in ratio. $\checkmark$

Vervang $24\,000 \text{ cm}^3 \cdot \text{mol}^{-1} / 24 \text{ dm}^3 \cdot \text{mol}^{-1}$ in $n = \frac{V}{V_M}$ of in verhouding.

- Final answer/Finale antwoord: $1\,152 \text{ cm}^3 / 1,152 \text{ dm}^3 \checkmark$

OPTION 1/OPSIE 1

$$\begin{aligned} n(\text{CO}_2) &= 3n[\text{Al}_2(\text{CO}_3)_3] \\ &= 3(0,016) \checkmark \\ &= 0,048 \text{ mol} \end{aligned}$$

$$n(\text{CO}_2) = \frac{V}{V_M}$$

$$\therefore 0,048 = \frac{V}{24000} \checkmark$$

$$V(\text{CO}_2) = 1\,152 \text{ cm}^3 (1,152 \text{ dm}^3) \checkmark$$

OPTION 2/OPSIE 2

$$\begin{aligned} n(\text{CO}_2) &= 3n[\text{Al}_2(\text{CO}_3)_3] \\ &= 3(0,016) \checkmark \\ &= 0,048 \text{ mol} \end{aligned}$$

$$1 \text{ mol} \dots\dots\dots 24\,000 \text{ cm}^3$$

$$0,048 \text{ mol} \dots\dots\dots V$$

$$V(\text{CO}_2) = \frac{0,048 \times 24000}{1} \checkmark$$

$$= 1\,152 \text{ cm}^3 (1,152 \text{ dm}^3) \checkmark$$

(3)
[13]

QUESTION 6/VRAAG 6

- 6.1 (The stage in a chemical reaction when the) rate of forward reaction equals the rate of reverse reaction. ✓✓
(Die stadium in 'n chemiese reaksie wanneer die) tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. (2 or/of 0)

OR/OF

- (The stage in a chemical reaction when the) concentrations of reactants and products remain constant.
(Die stadium in 'n chemiese reaksie wanneer die) konsentrasies van reaktanse en produkte konstant bly. (2 or/of 0) (2)

6.2

6.2.1 X ✓

ANY ONE/ENIGE EEN

- The concentration of products increases (from 0 – 6 min.).
Die konsentrasie van die produkte neem toe (van 0 - 6 min.).
- The concentration of reactants decreases (from 0 – 6 min.).
Die konsentrasie van die reaktanse neem af (van 0 – 6 min.).
- No products were present initially. ✓
Geen produkte was aanvanklik teenwoordig nie.
- The curve begins at zero./Die kurwe begin by nul. (2)

6.2.2 Higher than/Hoër as ✓

(1)

6.3 CALCULATIONS USING NUMBER OF MOLES BEREKENINGE WAT AANTAL MOL GEBRUIK

Marking criteria/Nasienkriteria

- Calculate/Bereken mol HI: $n(\text{HI})_{\text{ini/aanv.}} = 1(0,5)$. ✓
- Use mol ratio/Gebruik molverhouding: $2:1:1$ / $n(\text{HI}) = 2n(\text{H}_2) = 2n(\text{I}_2)$. ✓
- $n(\text{H}_2)_{\text{equilibrium/ewewig}} = n(\text{H}_2)_{\text{formed/gevorm}}$ } ✓
 $n(\text{I}_2)_{\text{equilibrium/ewewig}} = n(\text{I}_2)_{\text{formed/gevorm}}$ }
- **Note:** If Δn not shown award mark for equal $n_{\text{equilibrium}}$
Let wel: Indien Δn nie aangedui is nie, ken punt toe vir gelyke n_{ewewig}
- $n((\text{HI})_{\text{equilibrium/ewewig}} = n(\text{HI})_{\text{initial/aanvanklik}} - n(\text{HI})_{\text{change/verandering}}$. ✓
- Divide $n(\text{HI})_{\text{equil}}$ & $n(\text{H}_2)_{\text{equil}}$ & $n(\text{H}_2)_{\text{equil}}$ by $0,5 \text{ dm}^3$. ✓
Deel $n(\text{HI})_{\text{ewewig}}$ & $n(\text{H}_2)_{\text{ewewig}}$ & $n(\text{H}_2)_{\text{ewewig}}$ deur $0,5 \text{ dm}^3$.
- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c -uitdrukking (formules in vierkanthakies).
- Substitute 0,04 into K_c expression. ✓
Vervang 0,04 in K_c -uitdrukking.
- Substitute equilibrium concentrations in K_c expression. ✓
Vervang ewewigskonsentrasies in K_c -uitdrukking.
- Final answer/Finale antwoord: 0,07 mol ✓
Range/Gebied: 0,07 – 0,072 mol

OPTION 1/OPSIE 1

$$n(\text{HI}) = 1(0,5) = 0,5 \text{ mol}$$

	HI	H ₂	I ₂	
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	0,5 ✓	0	0	
Change (mol) <i>Verandering (mol)</i>	2x	x	x	ratio ✓ verhouding
Quantity at equilibrium (mol)/ <i>Hoeveelheid by ewewig (mol)</i>	0,5-2x ✓	x	x	
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	$\frac{0,5-2x}{0,5}$	$\frac{x}{0,5}$	$\frac{x}{0,5}$	divide by 0,5 ✓ deel deur 0,5

$$K_c = \frac{[\text{H}_2][\text{I}_2]}{[\text{HI}]^2} \checkmark$$

$$0,04 = \frac{\left(\frac{x}{0,5}\right)\left(\frac{x}{0,5}\right)}{\left(\frac{0,5-2x}{0,5}\right)^2} \checkmark$$

$$x = 0,071 \text{ mol} \checkmark$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./Maks. $\frac{8}{9}$

Wrong K_c expression /*Verkeerde K_c-uitdrukking*:
Max./Maks. $\frac{6}{9}$

CALCULATIONS USING CONCENTRATION**BEREKENINGE WAT KONSENTRASIE GEBRUIK****Marking criteria/Nasienkriteria:**

- Use initial/*Gebruik aanvanklike* $c(\text{HI}) = 1 \text{ mol} \cdot \text{dm}^{-3}$. ✓
- Use mol ratio/*Gebruik molverhouding*: 2 : 1 : 1 / $n(\text{HI}) = 2n(\text{H}_2) = 2n(\text{I}_2)$. ✓
- $c(\text{H}_2)_{\text{equilibrium/ewewig}} = c(\text{H}_2)_{\text{formed/gevorm}}$ } ✓
 $c(\text{I}_2)_{\text{equilibrium/ewewig}} = c(\text{I}_2)_{\text{formed/gevorm}}$ }
- **Note:** If Δc not shown award mark for equal $c_{\text{equilibrium}}$
Let wel: Indien Δc nie aangedui is nie, ken punt toe vir gelyke c_{ewewig}
- $c(\text{HI})_{\text{equilibrium/ewewig}} = c(\text{HI})_{\text{initial}} - c(\text{HI})_{\text{change}}$. ✓
- Correct K_c expression (*formulae in square brackets*). ✓
Korrekte K_c-uitdrukking (formules in vierkanthakies).
- Substitution of 0,04 into K_c expression. ✓
Vervang 0,04 in K_c-uitdrukking.
- Substitution of equilibrium concentrations into K_c expression. ✓
Vervanging van ewewigskonsentrasies in K_c-uitdrukking.
- Multiply concentration by 0,5 dm³. ✓
Vermenigvuldig konsentrasie met 0,5 dm³.
- Final answer/*Finale antwoord*: 0,07 mol ✓
Range/Gebied: 0,07 to/tot 0,072 mol

OPTION 2/OPSIE 2

	HI	H ₂	I ₂
Initial concentration (mol·dm ⁻³) <i>Aanvangskonsentrasie (mol·dm⁻³)</i>	1 ✓	0	0
Change (mol·dm ⁻³) <i>Verandering (mol·dm⁻³)</i>	2x	x	x
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	1-2x ✓	x	x ✓

$$K_c = \frac{[H_2][I_2]}{[HI]^2} \quad \checkmark$$

$$0,04 = \frac{(x)(x)}{(1-2x)^2} \quad \checkmark$$

$$x = 0,143 \text{ mol·dm}^{-3}$$

$$\begin{aligned} n(I_2) &= cV \\ &= 0,143 \times 0,5 \quad \checkmark \\ &= 0,072 \text{ mol} \quad \checkmark \end{aligned}$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./Maks. $\frac{8}{9}$

Wrong K_c expression /*Verkeerde K_c-uitdrukking*:
Max./Maks. $\frac{6}{9}$

(9)

6.4

6.4.1 Both forward and reverse/*Beide voorwaartse en terugwaartse* ✓

(1)

6.4.2 Positive/*Positief* ✓

- The forward reaction is favoured. ✓
Die voorwaartse reaksie word bevoordeel.
- An increase in temperature favours the endothermic reaction. ✓
'n Toename in temperatuur bevoordeel die endotermiese reaksie.
- The forward reaction is endothermic. ✓
Die voorwaartse reaksie is endotermies.

(4)

[19]

QUESTION 5/VRAAG 5

5. 1

NOTE/LET WELGive the mark for per unit time only if in context of reaction rate.Gee die punt vir per eenheidtyd slegs indien in konteks met reaksietempo.**ANY ONE/ENIGE EEN**

- Change in concentration ✓ of products/reactants per (unit) time. ✓
Verandering in konsentrasie van produkte/reaktanse per (eenheid) tyd.
- Change in amount/number of moles/volume/mass of products or reactants per (unit) time.
Verandering in hoeveelheid/getal mol/volume/massa van produkte of reaktanse per (eenheid) tyd.
- Amount/number of moles/volume/mass of products formed/reactants used per (unit) time.
Hoeveelheid/getal mol/volume/massa van produkte gevorm/reaktanse gebruik per (eenheid) tyd.
- Rate of change in concentration/amount/number of moles/volume/mass.
Tempo van verandering in konsentrasie/ hoeveelheid/getal mol/ volume/massa. ✓✓ (2 or/of 0)

(2)

5.2

5.2.1 Rate of the reaction/Reaksietempo ✓

(1)

5.2.2

Criteria for conclusion/Kriteria vir gevolgtrekking:Dependent (reaction rate) and independent (concentration) variables correctly identified./*Afhanklike(reaksietempo) en onafhanklike (konsentrasie) veranderlikes korrek geïdentifiseer.*

✓

Relationship between the independent and dependent variables correctly stated.
Verwantskap tussen die afhanklike en onafhanklike veranderlikes korrek genoem.

✓

Example/Voorbeeld:Reaction rate increases with increase in concentration./Reaction rate is proportional to concentration.*Reaksietempo neem toe met toename in konsentrasie./Reaksietempo is eweredig aan konsentrasie.***IF/INDIEN**DIRECTLY proportional/DIREK eweredig: Max/Maks.: $\frac{1}{2}$

(2)

5.3

5.3.1 Activation energy/(The boundary line for the) molecules with (adequate) kinetic energy to make effective collisions. ✓
Aktiveringsenergie/(Die grenslyn vir die) molekule met (genoeg) kintiese energie vir effektiewe botsings. (1)

5.3.2 B ✓ (1)

5.3.3

- At a higher temperature particles move faster/have a higher kinetic energy. ✓
By 'n hoër temperatuur beweeg die deeltjies vinniger/het die deeltjies hoër kinetiese energie.
- More molecules have enough/sufficient (kinetic) energy. ✓
Meer molekule het genoeg/voldoende (kinetiese) energie.
OR/OF
More molecules have (kinetic) energy equal to or greater than activation energy.
Meer molekule het (kinetiese) energie gelyk aan of groter as aktiveringsenergie.
- More effective collisions per unit time/second./Increased frequency of effective collisions.
Meer effektiewe botsings per eenheidtyd/sekonde./Frekwensie van effektiewe botsings neem toe.
- Reaction rate increases. ✓
Reaksietempo neem toe. (4)

5.4 Curve Y/it was obtained for the reaction where a catalyst was added. ✓
Kurwe Y/dit is vir die reaksie waar 'n katalisator bygevoeg is, verkry.

OR/OF
Curve X was obtained for the reaction in the absence of a catalyst.
Kurwe X is verkry vir die reaksie sonder 'n katalisator. (1)

5.5

Marking guidelines/Nasienriglyne

- Any formula/*Enige formule*: $n = \frac{m}{M}$ or/of $c = \frac{n}{V}$ ✓
- Substitute/*Vervang* 0,1 dm³ in $n = cV$ ✓
- Use mole ratio/*Gebruik molverhouding*:
 $n(S)_{\text{expected/verwag}} = \frac{1}{2}n(HCl)_{\text{used/gebruik}}$ ✓
- Substitution of/*Vervanging van* 32 g·mol⁻¹ in $n = \frac{m}{M}$ ✓
- SUBSTITUTE in/*VERVANG in*:
 $\frac{n(S)_{\text{produced/berai}}}{n(S)_{\text{expected/verwag}}} \times 100 / \frac{m(S)_{\text{produced/berai}}}{m(S)_{\text{expected/verwag}}} \times 100$ ✓
- Final answer/*Finale antwoord*: 56,25% to 60% ✓

OPTION 1/OPSIE 1

$$\begin{aligned}
 n(\text{HCl})_{\text{used/gebruik}} &= cV \checkmark \\
 &= 0,2 \times 0,1 \checkmark \\
 &= 0,02 \text{ mol} \\
 n(\text{S})_{\text{expected/verwag}} &= \frac{1}{2}n(\text{HCl})_{\text{used/gebruik}} \\
 &= \frac{1}{2}(0,02) \checkmark \\
 &= 0,01 \text{ mol} \\
 n(\text{S})_{\text{produced/berei}} &= \frac{m}{M} \\
 &= \frac{0,18}{32} \checkmark \\
 &= 0,0056 \text{ mol} \\
 \% \text{yield/opbrengs} &= \frac{n(\text{S})_{\text{prod./berei}}}{n(\text{S})_{\text{exp/verwag}}} \times 100 \\
 &= \frac{0,0056}{0,01} \times 100 \checkmark \\
 &= 56,25\% \checkmark
 \end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned}
 n(\text{HCl})_{\text{used/gebruik}} &= cV \checkmark \\
 &= 0,2 \times 0,1 \checkmark \\
 &= 0,02 \text{ mol} \\
 n(\text{S})_{\text{expected/verwag}} &= \frac{1}{2}n(\text{HCl})_{\text{used/gebruik}} \\
 &= \frac{1}{2}(0,02) \checkmark \\
 &= 0,01 \text{ mol} \\
 m(\text{S})_{\text{expected/verwag}} &= nM \\
 &= (0,01)(32) \checkmark \\
 &= 0,32 \text{ g} \\
 \% \text{yield/opbrengs} &= \frac{m(\text{S})_{\text{prod./berei}}}{m(\text{S})_{\text{exp/verwag}}} \times 100 \\
 &= \frac{0,18}{0,32} \times 100 \checkmark \\
 &= 56,25\% \checkmark
 \end{aligned}$$

(6)
[18]

QUESTION 6/VRAAG 6

- 6.1 Reversible reaction/Both forward and reverse reactions can take place./Products can be converted back to reactants. $\checkmark$
Omkeerbare reaksie/Beide voorwaartse en terugwaartse reaksies kan plaasvind./Produkte kan terugverander word na reaktanse. (1)
- 6.2 To favour the forward reaction/production of ammonia./To increase the yield of ammonia./Prevent the decomposition of NH_3 . $\checkmark$
Om die voorwaartse reaksie/produksie van ammoniak te bevoordeel./Om die ammoniak-opbrengs te verhoog./Voorkom die ontbinding van NH_3 . (1)
- 6.3 20(%) $\checkmark$ (1)

6.4

6.4.1

At 500 °C lower yield of ammonia:

- The (forward) reaction is exothermic./Reverse reaction is endothermic. ✓
Die (voorwaartse) reaksie is eksotermies./Terugwaartse reaksie is endotermies.
- An increase in temperature favours the endothermic reaction. ✓
'n Toename in temperatuur bevoordeel die endotermiese reaksie.
- The reverse reaction is favoured. ✓
Die terugwaartse reaksie word bevoordeel.

OR/OF

At 350 °C higher yield of ammonia:

- The (forward) reaction is exothermic./Reverse reaction is endothermic. ✓
Die (voorwaartse) reaksie is eksotermies./Terugwaartse reaksie is endotermies.
- A decrease in temperature favours the exothermic reaction. ✓
'n Afname in temperatuur bevoordeel die eksotermiese reaksie.
- The forward reaction is favoured. ✓
Die voorwaartse reaksie word bevoordeel.

(3)

6.4.2

At 350 atm higher yield of ammonia:

- An increase in pressure favours the reaction that produces the lower number of moles/number of molecules/volume of gas. ✓
'n Toename in druk bevoordeel die reaksie wat die kleiner aantal mol/aantal molekule/volume gas lewer.
- The forward reaction is favoured. ✓
Die voorwaartse reaksie word bevoordeel.

OR/OF

At 150 atm lower yield of ammonia:

- A decrease in pressure favours the reaction that produces the higher number of moles/number of molecules/volume of gas. ✓
'n Afname in druk bevoordeel die reaksie wat die groter aantal mol/aantal molekule/volume gas lewer.
- Reverse reaction is favoured. ✓
Die terugwaartse reaksie word bevoordeel.

(2)

6.5

6.5.1

1 mol N₂ reacts with 3 mol H₂ to produce 2 mol NH₃

∴ 2 mol N₂ reacts with 6 mol H₂ to produce 4 (mol) NH₃ ✓✓ (2 or 0)

1 mol N₂ reageer met 3 mol H₂ om 2 mol NH₃ te lewer

∴ 2 mol N₂ reageer met 6 mol H₂ om 4 (mol) NH₃ te vorm (2 of 0)

(2)

6.5.2 POSITIVE MARKING FROM QUESTION 6.5.1.

Marking criteria/Nasienriglyne:

- Calculate 35% of 4 mol NH_3 (answer from Q6.5.1). ✓
- Use mol ratio/*Gebruik molverhouding* $n(\text{N}_2) : n(\text{H}_2) : n(\text{NH}_3) = 1 : 3 : 2$ ✓
- Equilibrium/*Ewewig* $n(\text{N}_2) = \text{initial/aanvanklike } n(\text{N}_2) - \Delta n(\text{N}_2)$ } ✓
Equilibrium/*Ewewig* $n(\text{H}_2) = \text{initial/aanvanklike } n(\text{H}_2) - \Delta n(\text{H}_2)$ }
- Divide by/*Deel deur* $0,5 \text{ dm}^3$. ✓
- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c uitdrukking (formules in vierkantige hakies).
- Substitution of concentrations into correct K_c expression. ✓
Vervanging van konsentrasies in korrekte K_c -uitdrukking.
- Final answer/*Finale antwoord*: 0,002 ✓
Range/Gebied: 0,00155 to 0,002 ($1,55 \times 10^{-3}$ to 2×10^{-3})

$$n(\text{NH}_3) = \frac{35}{100} \times 4 \checkmark$$

$$= 1,4 \text{ mol}$$

	N_2	H_2	NH_3
Initial amount (moles) <i>Aanvangs hoeveelheid (mol)</i>	6	6	0
Change in amount (moles) <i>Verandering in hoeveelheid (mol)</i>	0,7	2,1	1,4
Equilibrium amount (moles) <i>hoeveelheid (mol)</i>	5,3	3,9 ✓	1,4
Equilibrium concentration ($\text{mol} \cdot \text{dm}^{-3}$) <i>Ewewigskonsentrasie ($\text{mol} \cdot \text{dm}^{-3}$)</i>	10,6	7,8	2,8

ratio ✓
verhouding

Divide by
 $0,5 \text{ dm}^3$ ✓

$$K_c = \frac{[\text{NH}_3]^2}{[\text{H}_2]^3 [\text{N}_2]} \checkmark$$

$$= \frac{(2,8)^2}{(7,8)^3 (10,6)} \checkmark$$

$$= 0,002 \checkmark$$

No K_c expression, correct substitution/*Geen K_c -uitdrukking, korrekte substitusie*: Max./Maks. $\frac{6}{7}$

Wrong K_c expression/*Verkeerde K_c -uitdrukking*:
Max./Maks. $\frac{4}{7}$

(7)
[17]

QUESTION 5/VRAAG 5

5.1 **ONLY ANY ONE OF/SLEGS ENIGE EEN VAN:**

- Change in concentration of products/reactants ✓ per (unit) time. ✓
Verandering in konsentrasie van produkte/reaktanse per (eenheids)tyd.
- Rate of change in concentration. ✓✓
Tempo van verandering in konsentrasie.
- Change in amount/number of moles/volume/mass ✓ of products or reactants per (unit) time. ✓
Verandering in hoeveelheid/aantal mol/volume/massa van produkte of reaktanse per (eenheids)tyd.
- Amount/number of moles/volume/mass (of products) formed/(reactants) used ✓ per (unit) time. ✓
Hoeveelheid/aantal mol/volume/massa (van produkte) gevorm/(reaktanse) gebruik per (eenheids)tyd. (2)

5.2

- 5.2.1 Surface area/State of division ✓
Oppervlakte/Toestand van verdeeldheid (1)

5.2.2 **ANY ONE/ENIGE EEN:**

- Amount/mass of magnesium ✓
Hoeveelheid/massa magnesium
- Concentration of HCl/acid/Konsentrasie van HCl /suur
- (Initial) temperature/(Aanvanklike) temperatuur (1)

Marking criteria/Nasienriglyne

- Calculate change in $m(\text{Mg})$ or $n(\text{Mg})$ ✓
Bereken verandering in $m(\text{Mg})$ of $n(\text{Mg})$
- Substitute/Vervang $24 \text{ g} \cdot \text{mol}^{-1}$ in $n = \frac{m}{M}$ ✓
- Use mol ratio/Gebruik molverhouding: $n(\text{Mg}) = n(\text{H}_2) = 1:1$ ✓
- Substitute/Vervang 25 dm^3 in $n = \frac{V}{V_m}$ ✓
- Final answer/Finale antwoord: $2,5 \text{ dm}^3$ ✓

OPTION 1/OPSIE 1

$$\begin{aligned}\Delta m(\text{Mg}) &= 2,6 - 0,2 \checkmark \\ &= 2,4 \text{ g} \\ n(\text{Mg}_{\text{used/gebruik}}) &= \frac{m}{M} \\ &= \frac{2,4}{24} \checkmark \\ &= 0,1 \text{ mol} \\ n(\text{H}_2) &= n(\text{Mg}) = 0,1 \text{ mol} \checkmark \\ V(\text{H}_2) &= nV_m \\ V(\text{H}_2) &= (0,1)(25) \checkmark \\ &= 2,5 \text{ dm}^3 \checkmark\end{aligned}$$

OPTION 2/OPSIE 2

$$\begin{aligned}n(\text{Mg})_{t=2s} &= \frac{m}{M} = \frac{2,6}{24} \checkmark = 0,1083 \text{ mol} \\ n(\text{Mg})_{t=10s} &= \frac{0,2}{24} = 0,0083 \text{ mol} \\ \Delta n(\text{Mg}) &= 0,1083 - 0,0083 \checkmark \\ &= 0,1 \text{ mol} \\ n(\text{H}_2) &= n(\text{Mg}) = 0,1 \text{ mol} \checkmark \\ V(\text{H}_2) &= nV_m \\ V(\text{H}_2) &= (0,1)(25) \checkmark \\ &= 2,5 \text{ dm}^3 \checkmark\end{aligned}$$

OPTION 3/OPSIE 3

$$\begin{aligned}24 \text{ g Mg} &\checkmark \longrightarrow 25 \text{ dm}^3 \text{ H}_2 \\ \therefore 2,4 \text{ g} &\checkmark \longrightarrow x \text{ dm}^3 \text{ H}_2 \\ x &= \frac{2,4 \times 25}{24} \checkmark \\ &= 2,5 \text{ dm}^3 \checkmark\end{aligned}$$

(5)

Marking criteria/Nasiennriglyne

- Substitute/Vervang $2,08 \times 10^{-4}$ in ave rate / *gem. tempo* = $\frac{\Delta n}{\Delta t}$ ✓
- Substitute/Vervang 10×60 s (600 s) in ave rate / *gem. tempo* = $\frac{\Delta n}{\Delta t}$ ✓
- Use mol ratio/Gebruik molverhouding: $n(\text{Mg}) = n(\text{H}_2) = 1:1$ ✓
- Substitute/Vervang $24 \text{ g} \cdot \text{mol}^{-1}$ in $m = nM$. ✓
- Final answer/Finale antwoord: 3 g ✓ (Range/Gebied 2,995 – 3,12 g)

$$\text{ave rate / gem. tempo} = \frac{\Delta n}{\Delta t}$$

$$\therefore 2,08 \times 10^{-4} = \frac{\Delta n}{(10 \times 60) - 0} \checkmark$$

$$\therefore \Delta n = 0,125 \text{ mol}$$

$$n(\text{Mg}) = n(\text{H}_2) = 0,125 \text{ mol} \checkmark$$

$$m(\text{Mg}) = nM$$

$$m(\text{Mg}) = 0,125 \times 24 \checkmark$$

$$= 3 \text{ g} \checkmark (2,995 \text{ g})$$

(5)

5.4

- Larger surface area/state of division. ✓
Groter reaksieoppervlak/toestand van verdeeldheid
- More particles (per volume) with correct orientation/Meer deeltjies (per volume) met korrekte oriëntasie. ✓

OR/OFMore contact points./Meer kontakpunte.

- More effective collisions per (unit) time./Frequency of effective collisions increases./More particles collide with sufficient kinetic energy & correct orientation per (unit) time. ✓✓

Meer effektiewe botsings per (eenheids)tyd./Frekwensie van effektiewe botsings verhoog./Meer deeltjies bots met genoeg kinetiese energie & korrekte oriëntasie per tyd(seenheid).

(3)

[17]

QUESTION 6/VRAAG 6

- 6.1 The stage in a chemical reaction when the rate of forward reaction equals the rate of reverse reaction. Both forward and reverse reactions take place at same rate. ✓✓

Die stadium in 'n chemiese reaksie wanneer die tempo van die voorwaartse reaksie gelyk is aan die tempo van die terugwaartse reaksie. Beide voor- en terugwaartse reaksies vind teen dieselfde tempo plaas.

OR/OF

The stage in a chemical reaction when the concentrations of reactants and products remain constant. ✓✓

Die stadium in 'n chemiese reaksie wanneer die konsentrasies van reaktanse en produkte konstant bly.

(2)

6.2

6.2.1 2 ✓

(1)

6.2.2 1 ✓

(1)

6.2.3 3 ✓

(1)

6.3 **POSITIVE MARKING FROM QUESTION 6.2.**
POSITIEWE NASIEN VANAF VRAAG 6.2.

Marking criteria/Nasienriglyne:

- Substitute/Vervang 8 mol in $c = \frac{n}{V}$ ✓
- Substitute/Vervang 4 mol in $c = \frac{n}{V}$ ✓
- Substitute/Vervang 12 mol in $c = \frac{n}{V}$ ✓
- Substitute/Vervang $V = 3 \text{ dm}^3$ in the above THREE formulae/in die bostaande DRIE formules. ✓
- K_c expression/uitdrukking ✓
- Substitution of concentrations into K_c expression ✓
Vervanging van konsentrasies in K_c -uitdrukking.
- Final answer/Finale antwoord: 6,75 ✓

OPTION 1/OPSIE 1

$$[A] = \frac{8}{3} = 2,67 \text{ mol} \cdot \text{dm}^{-3}$$

$$[B] = \frac{4}{3} = 1,33 \text{ mol} \cdot \text{dm}^{-3} \quad \text{Divide by/Deel deur } 3 \text{ dm}^3 \checkmark$$

$$[C] = \frac{12}{3} = 4 \text{ mol} \cdot \text{dm}^{-3}$$

$$K_c = \frac{[C]^3}{[A]^2[B]} \checkmark$$

$$= \frac{(4)^3}{(2,67)^2(1,33)} \checkmark$$

$$= 6,75 \checkmark$$

No K_c expression, correct substitution /Geen K_c -uitdrukking, korrekte substitusie: Max./Maks. $\frac{6}{7}$

Wrong K_c expression /Verkeerde K_c -uitdrukking:
Max./Maks. $\frac{4}{7}$

OPTION 2/OPSIE 2

	A	B	C	
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	16	8	0	
Change (mol) <i>Verandering (mol)</i>	8	4	12	
Quantity at equilibrium (mol) <i>Hoeveelheid by ewewig (mol)</i>	8 ✓	4 ✓	12 ✓	
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	$\frac{8}{3}$	$\frac{4}{3}$	$\frac{12}{3}$	Divide by /deel deur 3 dm ³ ✓

$$K_c = \frac{[C]^3}{[A]^2[B]} \checkmark$$

$$= \frac{(4)^3}{(2,67)^2(1,33)} \checkmark$$

$$= 6,75 \checkmark$$

No K_c expression, correct substitution / *Geen K_c-uitdrukking, korrekte substitusie*: Max./Maks. $\frac{6}{7}$

Wrong K_c expression / *Verkeerde K_c-uitdrukking*:
Max./Maks. $\frac{4}{7}$

(7)

USING CONCENTRATION/GEbruik KONSENTRASIE**OPTION 3/OPSIE 3**

	A	B	C	
Initial concentration (mol·dm ⁻³) <i>Aanvangskonsentrasie (mol·dm⁻³)</i>	$\frac{16}{3} = 5,33$	$\frac{8}{3} = 2,67$	0	
Change (mol·dm ⁻³) <i>Verandering (mol·dm⁻³)</i>	$\frac{8}{3} = 2,67$	$\frac{4}{3} = 1,33$	$\frac{12}{3} = 4$	÷3 dm ³ ✓
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	$\frac{8}{3} = 2,67 \checkmark$	$\frac{4}{3} = 1,33 \checkmark$	$\frac{12}{3} = 4 \checkmark$	

$$K_c = \frac{[C]^3}{[A]^2[B]} \checkmark$$

$$= \frac{(4)^3}{(2,67)^2(1,33)} \checkmark$$

$$= 6,75 \checkmark$$

No K_c expression, correct substitution / *Geen K_c-uitdrukking, korrekte substitusie*: Max./Maks. $\frac{6}{7}$

Wrong K_c expression / *Verkeerde K_c-uitdrukking*:
Max./Maks. $\frac{4}{7}$

(7)

6.4 Endothermic/Endotermies ✓



- (An increase in temperature) favours the reverse reaction. ✓
(*'n Toename in temperatuur*) bevoordeel die terugwaartse reaksie.
- An increase in temperature favours an endothermic reaction. ✓
(*'n Toename in temperatuur*) bevoordeel 'n endotermiese reaksie.

(3)
[15]

QUESTION/VRAAG 5

5.1 ANY TWO/ENIGE TWEE:

Temperature (of reaction mixture)/Temperatuur (van reaksiemengsel) ✓

(Addition of a) catalyst/(Byvoeging van 'n) katalisator ✓

Concentration (of reactants)/Konsentrasie (van reaktanse)

(2)

5.2 Sulphur/S/Swawel ✓

(1)

5.3 Water is used to dilute/change the concentration (of the $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$) ✓Water word gebruik (om die $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$) te verdun/se konsentrasie te verander.

(1)

5.4

Criteria for investigative question/Kriteria vir ondersoekende vraag:	
The <u>dependent</u> and <u>independent</u> variables are stated correctly. <i>Die afhanklike en onafhanklike veranderlikes word korrek genoem.</i>	✓
Asks a question about the relationship between <u>dependent</u> and <u>independent</u> variables./Vra 'n vraag oor die verwantskap tussen <u>afhanklike</u> en <u>onafhanklike</u> veranderlikes.	✓

Dependent variable: rate (of reaction)/(reaction rate)**Afhanklike veranderlike:** (reaksie)tempo**Independent variable:** concentration**Onafhanklike veranderlike:** konsentrasie**Examples/Voorbeelde:**

- What is the relationship between concentration and reaction rate?

Wat is die verwantskap tussen konsentrasie en reaksietempo?

- How does the reaction rate change with change in concentration?

Hoe verander die reaksietempo met verandering in konsentrasie?

(2)

5.5 A ✓

(1)

5.6 **Experiment B/Eksperiment B:**

- The concentration of $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$ is higher./More $\text{Na}_2\text{S}_2\text{O}_3$ particles per unit volume. ✓ Accept: higher volume of $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$ is used
Die konsentrasie van $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$ is hoër./Meer $\text{Na}_2\text{S}_2\text{O}_3$ -deeltjies per eenheid volume. Aanvaar: Groter volume $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$ is gebruik
- More particles with correct orientation / Meer deeltjies met korrekte oriëntasie. ✓
- More effective collisions per unit time / Higher frequency of effective collisions. ✓
Meer effektiewe botsings per eenheid tyd./Hoër frekwensie van effektiewe botsings.

OR/OF**Experiment D/Eksperiment D:**

- The concentration of $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$ is lower./Less $\text{Na}_2\text{S}_2\text{O}_3$ particles per unit volume. ✓
Die konsentrasie van $\text{Na}_2\text{S}_2\text{O}_3(\text{aq})$ is laer./Minder $\text{Na}_2\text{S}_2\text{O}_3$ -deeltjies per eenheid volume.
- Less particles with correct orientation./Minder deeltjies met korrekte oriëntasie. ✓
- Less effective collisions per unit time./Lower frequency of effective collisions. ✓
Minder effektiewe botsings per eenheid tyd./Laer frekwensie van effektiewe botsings.

(3)

Marking guidelines for Option 1 and 2/Nasiënriqlyne vir Opsie 1 en 2:

- Formula/Formule: $c = \frac{m}{MV}$ / Both/Beide $n = \frac{m}{M}$ and/en $c = \frac{n}{V}$ or/of ratio / verhouding ✓
- Use/Gebruik $158 \text{ g} \cdot \text{mol}^{-1}$ ✓
- Use volume (250 cm^3) to calculate $c(\text{Na}_2\text{S}_2\text{O}_3)$ or $m(\text{Na}_2\text{S}_2\text{O}_3)$. ✓
Gebruik volume (250 cm^3) om $c(\text{Na}_2\text{S}_2\text{O}_3)$ of $m(\text{Na}_2\text{S}_2\text{O}_3)$ te bereken.
- Calculate $n(\text{Na}_2\text{S}_2\text{O}_3)$. /Bereken $n(\text{Na}_2\text{S}_2\text{O}_3)$. ✓
- Use ratio/Gebruik verhouding: $n(\text{S}) = (\text{Na}_2\text{S}_2\text{O}_3) = 1:1$ ✓
- Use/Gebruik $32 \text{ g} \cdot \text{mol}^{-1}$. ✓
- Final answer/Finale antwoord: $0,51 \text{ g}$ ✓
- Accepted range/Aanvaarde gebied: $0,50$ to $0,51 \text{ g}$

Marking guidelines for Option 3 and 4/Nasiënriqlyne vir Opsie 3 en 4:

- Use volume (250 cm^3) /Gebruik volume (250 cm^3)
- Use $m(\text{Na}_2\text{S}_2\text{O}_3)$. $62,5 \text{ g}$ /Gebruik $m(\text{Na}_2\text{S}_2\text{O}_3) = 62,5 \text{ g}$
- Use/Gebruik $158 \text{ g} \cdot \text{mol}^{-1}$ ✓
- Calculate $n(\text{Na}_2\text{S}_2\text{O}_3)$ or $m(\text{Na}_2\text{S}_2\text{O}_3)$. /Bereken $n(\text{Na}_2\text{S}_2\text{O}_3)$ of $m(\text{Na}_2\text{S}_2\text{O}_3)$. ✓
- Use ratio/Gebruik verhouding: $n(\text{S}) = (\text{Na}_2\text{S}_2\text{O}_3) = 1:1$ ✓
- Use/Gebruik $32 \text{ g} \cdot \text{mol}^{-1}$. ✓
- Final answer/Finale antwoord: $0,51 \text{ g}$ ✓
- Accepted range/Aanvaarde gebied: $0,50$ to $0,51 \text{ g}$

OPTION/OPSIE 1	OPTION/OPSIE 2	OPTION/OPSIE 3	OPTION/OPSIE 4
$c = \frac{m}{MV}$ ✓ $= \frac{62,5}{(158)(0,25)}$ ✓ $= 1,58 \text{ mol} \cdot \text{dm}^{-3}$	$n = \frac{m}{M}$ ✓ $= \frac{62,5}{158}$ ✓ $= 0,396 \text{ mol}$ $c = \frac{n}{V}$ $= \frac{0,396}{0,25}$ ✓ $= 1,58 \text{ mol} \cdot \text{dm}^{-3}$	$250 \text{ cm}^3 \dots\dots 62,5 \text{ g}$ $10 \text{ cm}^3 \dots\dots \frac{10}{250} \times 62,5$ ✓ $\therefore m(\text{Na}_2\text{S}_2\text{O}_3 \text{ in D}) = 2,5 \text{ g}$ $n(\text{Na}_2\text{S}_2\text{O}_3 \text{ in D}) = \frac{m}{M}$ $= \frac{2,5}{158}$ ✓ $= 0,0158 \text{ mol}$	$250 \text{ cm}^3 \dots\dots 62,5 \text{ g}$ $10 \text{ cm}^3 \dots\dots \frac{10}{250} \times 62,5$ ✓ $\therefore m(\text{Na}_2\text{S}_2\text{O}_3 \text{ in D}) = 2,5 \text{ g}$ $158 \text{ g} \dots\dots 32 \text{ g S}$ ✓ $2,5 \text{ g} \dots\dots x \text{ g}$ $m(x) = \frac{2,5 \times 32}{158}$ ✓ $= 0,51 \text{ g}$ ✓
$n(\text{Na}_2\text{S}_2\text{O}_3 \text{ in D}) = cV$ $= (1,58)(0,01)$ ✓ $= 0,0158 \text{ mol}$	$n(\text{S}) = (\text{Na}_2\text{S}_2\text{O}_3)$ ✓ $= 0,0158$ $n = \frac{m}{M}$ $0,0158 = \frac{m}{32}$ ✓		

(7)
[17]

$$m = 0,51 \text{ g}$$

QUESTION/VRAAG 6

6.1 Reversible reaction/Omkeerbare reaksie ✓ (1)

6.2 Endothermic/Endotermies ✓



ΔH is positive./ $\Delta H > 0$ /(Net) energy is absorbed./More energy is absorbed than released/Energy of product > energy of reactant. ✓

ΔH is positief./ $\Delta H > 0$ /(Netto) energie word opgeneem./Meer energie word geabsorbeer as vrygestel./Energie van produk > Energie van reaktans (2)

6.3 Larger than/Groter as ✓



$K_c > 1$ ✓ (2)

6.4 **CALCULATIONS USING NUMBER OF MOLES** **BEREKENINGE WAT GETAL MOL GEBRUIK**

Mark allocation/Puntetoekenning:

- Calculate $n(\text{CO})_{\text{equilibrium}}$ i.e. divide m by $28 \text{ g} \cdot \text{mol}^{-1}$ OR substitute 6 mol for equilibrium mole of CO. ✓
Bereken $n(\text{CO})_{\text{ewewig}}$ d.i. deel m deur $28 \text{ g} \cdot \text{mol}^{-1}$ OF vervang 6 mol vir ewewigsmol van CO.
- Change in $n(\text{CO}) = \text{equilibrium } n(\text{CO}) - \text{initial } n(\text{CO})$ ✓
Verandering in $n(\text{CO}) = \text{ewewig } n(\text{CO}) - \text{aanvanklike } n(\text{CO})$
- **USING** ratio/**GEBRUIK** verhouding: $\text{CO}_2 : \text{CO} = 1 : 2$ ✓
- Equilibrium $n(\text{CO}_2) = \text{initial } n(\text{CO}_2) - \text{change } n(\text{CO}_2)$. ✓
Ewewig $n(\text{CO}_2) = \text{aanvanklike } n(\text{CO}_2) - \text{verandering } n(\text{CO}_2)$.
- Equilibrium mole of both CO_2 and CO divided by 2 dm^3 . ✓
Ewewigsmol van beide CO_2 en CO gedeel deur 2 dm^3
- Correct K_c expression (formulae in square brackets). ✓
Korrekte K_c -uitdrukking (formules in vierkanthakies).
- Substitution of concentrations into K_c expression. ✓
Vervanging van konsentrasies in K_c -uitdrukking.
- Substitution of K_c value/Vervanging van K_c -waarde. ✓
- Final answer/Finale antwoord: 4,28–4,29 (mol) ✓

OPTION 1/OPSIE 1

$$n = \frac{m}{M}$$

$$= \frac{168}{28} \checkmark$$

$$= 6 \text{ mol}$$

	CO ₂	CO	
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	x	0	
Change (mol) <i>Verandering (mol)</i>	3	6 ✓	ratio ✓ verhouding
Quantity at equilibrium (mol)/ <i>Hoeveelheid by ewewig (mol)</i>	x - 3 ✓	6	
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	$\frac{x-3}{2}$	3	Divide by 2 ✓

$$K_c = \frac{[\text{CO}]^2}{[\text{CO}_2]} \checkmark$$

$$14 \checkmark = \frac{(3)^2}{\frac{x-3}{2}} \checkmark$$

$$\therefore x = 4,29 \text{ mol} \checkmark$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./Maks. $\frac{8}{9}$

Wrong K_c expression/*Verkeerde K_c-uitdrukking*:
Max./Maks. $\frac{6}{9}$

OPTION 2/OPSIE 2

$$n = \frac{m}{M}$$

$$= \frac{168}{28} \checkmark$$

$$= 6 \text{ mol}$$

$$c = \frac{n}{V}$$

$$= \frac{6}{2} \text{ Divide by/Deel deur 2 } \checkmark$$

$$= 3 \text{ mol} \cdot \text{dm}^{-3}$$

	CO ₂	CO	
Initial concentration (mol·dm ⁻³) <i>Aanvangskonsentrasie (mol·dm⁻³)</i>	x	0	
Change (mol·dm ⁻³) <i>Verandering (mol·dm⁻³)</i>	1,5	3 ✓	ratio ✓ verhouding
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	x - 1,5 ✓	3	

$$K_c = \frac{[\text{CO}]^2}{[\text{CO}_2]} \checkmark$$

$$14 \checkmark = \frac{[3]^2}{x-1,5} \checkmark$$

$$\therefore x = 2,14 \text{ mol} \cdot \text{dm}^{-3}$$

$$n(\text{CO}_2) = cV$$

$$= (2,14)(2)$$

$$= 4,29 \text{ mol} \checkmark$$

No K_c expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./Maks. $\frac{8}{9}$

Wrong K_c expression/*Verkeerde K_c-uitdrukking*:
Max./Maks. $\frac{6}{9}$

OPTION 3/OPSIE 3

$$n = \frac{m}{M}$$

$$= \frac{168}{28} \quad \checkmark$$

$$= 6 \text{ mol}$$

	CO ₂	CO
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	4,28 ✓	0
Change (mol) <i>Verandering (mol)</i>	3	6
Quantity at equilibrium (mol)/ <i>Hoeveelheid by ewewig (mol)</i>	1,28 ✓	6 ✓
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigskonsentrasie (mol·dm⁻³)</i>	0,64	3

ratio ✓
verhouding

multiply by 2 ✓
vermenigvuldig met 2

$$K_c = \frac{[\text{CO}]^2}{[\text{CO}_2]} \quad \checkmark$$

$$14 \quad \checkmark = \frac{[3]^2}{[\text{CO}_2]} \quad \checkmark$$

$$\therefore [\text{CO}_2] = 0,64 \text{ mol·dm}^{-3}$$

No K_C expression, correct substitution/*Geen K_c-uitdrukking, korrekte substitusie*: Max./Maks. $\frac{8}{9}$

Wrong K_C expression/*Verkeerde K_c-uitdrukking*:
Max./Maks. $\frac{6}{9}$

(9)

6.5

6.5.1 Remains the same/*Bly dieselfde* ✓

(1)

6.5.2 Decreases/*Verminder* ✓

(1)

6.5.3 Increases/*Vermeerder* ✓

(1)

[17]

QUESTION/VRAAG 5

5.1

5.1.1 To measure volume / amount ✓ of gas/oxygen produced.
Om die volume van die gas / suurstof berei te meet. (1)

5.1.2 Catalyst / Speeds up the reaction. / Increases reaction rate. ✓
Katalisator / Versnel die reaksie. / Verhoog die reaksietempo. (1)

5.2 No gas / bubbles produced. / Geen gas / borrels word gevorm nie. ✓
OR/OF
Volume of gas in syringe remains constant. / The plunger stops moving.
Volume van gas in spuit bly konstant. / Die suier hou op beweeg. (1)

5.3 CuO / Copper(II) oxide / catalyst ✓
CuO / koper(II)oksied / katalisator (1)

5.4

- A catalyst provides an alternative pathway of lower activation energy. ✓
'n Katalisator verskaf 'n pad van laer aktiveringsenergie.
- More molecules have sufficient / enough kinetic energy. / Meer molekule het voldoende/genoeg kinetiese energie. ✓

OR/OF
More molecules have kinetic energy equal to or greater than the activation energy. / Meer molekule het kinetiese energie gelyk aan of groter as die aktiveringsenergie.

- More effective collisions per unit time. / Frequency of effective collisions increases. ✓
Meer effektiewe botsings per eenheidtyd. / Frekwensie van effektiewe botsings neem toe. (3)

5.5

5.5.1 Released / Vrygestel ✓

Products at lower (potential) energy than reactant. / Reaction is exothermic / $\Delta H < 0$ ✓

Produkte by laer (potensiële) energie as reaktans. / Reaksie is eksotermies. / $\Delta H < 0$

(2)

5.5.2 B ✓

(1)

5.6

$n(\text{O}_2)_{\text{produced}} = \frac{V}{V_m}$ $= \frac{0,4}{25} \checkmark$ $= 0,016 \text{ mol}$	Marking criteria/Nasienriglyne: - Use $0,4 \text{ dm}^3$ and 25 dm^3 to calculate $n(\text{O}_2)$. ✓ Gebruik $0,4 \text{ dm}^3$ en 25 dm^3 om $n(\text{O}_2)$ te bereken. - Use/Gebruik $n(\text{H}_2\text{O}_2) = 2n(\text{O}_2)$. ✓ - Substitute/Vervang $0,05 \text{ dm}^3$ in a/n relevant formula /relevante formula ✓ - Substitute $\Delta c/\Delta n$ in rate formula. ✓ Vervang $\Delta c/\Delta n$ in tempoformule. - Substitute Δt in rate formula ✓ Vervang Δt in tempoformule. - Final answer/Finale antwoord: $0,11 \text{ mol} \cdot \text{dm}^{-3} \cdot \text{min}^{-1}$ ✓ Range/Gebied: $0,11$ to $0,14 \text{ mol} \cdot \text{dm}^{-3} \cdot \text{min}^{-1}$
OPTION/OPSIE 1 $n(\text{H}_2\text{O}_2)_{\text{used/gebruik}} = 2(0,016) \checkmark$ $= 0,032 \text{ mol}$ $[\text{H}_2\text{O}_2] = \frac{n}{V}$ $= \frac{0,032}{0,05} \checkmark$ $= 0,64 \text{ mol} \cdot \text{dm}^{-3}$ $\text{Rate/tempo} = -\frac{\Delta c}{\Delta t}$ $= -\frac{0 - 0,64}{5,8 - 0} \checkmark$ $= 0,11 \text{ (mol} \cdot \text{dm}^{-3} \cdot \text{min}^{-1})$ 1) ✓ Accept /Aanvaar: $\frac{0,64}{5,8}$ ✓ and $\frac{-0,64}{5,8}$ ✓	OPTION/OPSIE 2 Rate at which O_2 is formed: Tempo waarteen O_2 vorm: $\text{rate} = \frac{\Delta n}{\Delta t}$ $= \frac{0,016 - 0}{5,8 - 0} \checkmark$ $= 2,76 \times 10^{-3} \text{ mol} \cdot \text{min}^{-1}$ $\text{Rate/tempo } \text{H}_2\text{O}_2 \text{ used} = 2(\text{rate } \text{O}_{2\text{formed}})$ $= 2(2,76 \times 10^{-3}) \checkmark$ $= 5,52 \times 10^{-3} \text{ mol} \cdot \text{min}^{-1}$ $\text{Rate/tempo} = \frac{5,52 \times 10^{-3}}{0,05} \checkmark$ $= 0,11 \text{ (mol} \cdot \text{dm}^{-3} \cdot \text{min}^{-1}) \checkmark$

(6)

[16]

QUESTION/VRAAG 6

6.1

- 6.1.1 Products can be converted back to reactants. ✓
Produkke kan omgeskakel word na reaktanse.

OR/OF

Both forward and reverse reactions can take place.
Beide voor-en terugwaartse reaksies kan plaasvind.

(1)

- 6.1.2 Endothermic/Endotermies ✓

(1)

- 6.1.3
- K_c increases with increase in temperature. ✓
 K_c neem toe met toename in temperatuur.
 - Forward reaction is favoured. / Concentration of products increases. / Concentration of reactants decreases. ✓
Voorwaartse reaksie word bevoordeel. / Konsentrasie van produkte neem toe. / Konsentrasie van reaktanse neem af.
 - Increase in temperature favours an endothermic reaction. ✓
Toename in temperatuur bevoordeel 'n endotermiese reaksie.

(3)

- 6.1.4 Increases / Vermeerder ✓

(1)

- 6.1.5 Remains the same / Bly dieselfde ✓

(1)

6.2

6.2.1

Marking criteria/Nasienriglyne:

- (a) Use $48 \text{ g} \cdot \text{mol}^{-1}$ to calculate $n(\text{Ti})$. ✓
Gebruik $48 \text{ g} \cdot \text{mol}^{-1}$ om $n(\text{Ti})$ te bereken.
- (b) Use $71 \text{ g} \cdot \text{mol}^{-1}$ to calculate $n(\text{Cl}_2)$. ✓
Gebruik $71 \text{ g} \cdot \text{mol}^{-1}$ om $n(\text{Cl}_2)$ te bereken.
- (c) Use mole ratio/Gebruik molverhouding: $n(\text{Cl}_2) = 2n(\text{Ti})$. ✓
- (d) $n(\text{Cl}_2)_{\text{equilibrium/ewewig}} = n(\text{Cl}_2)_{\text{initial/aanvanklik}} - n(\text{Cl}_2)_{\text{reacted/reageer}}$. ✓
- (e) Divide by volume/Deel deur volume. ✓
- (f) K_c expression/ K_c uitdrukking. ✓
- (g) Substitution of $c(\text{Cl}_2)$ in K_c /Vervanging van $c(\text{Cl}_2)$ in K_c . ✓
- (h) Final answer/Finale antwoord: 0,25 ✓

OPTION/OPSIE 1

	Cl ₂	Ti	
Initial quantity (mol) <i>Aanvangshoeveelheid (mol)</i>	6 ✓(b)	7 ✓(a)	
Change (mol)/ <i>Verandering (mol)</i>	2	1	Use mole ratio ✓(c) <i>Gebruik molverhouding</i>
Quantity at equilibrium (mol) <i>Hoeveelheid by ewewig (mol)</i>	4 ✓(d)	6 (a)	
Equilibrium concentration (mol·dm ⁻³) <i>Ewewigkonsentrasie (mol·dm⁻³)</i> □	2		Divide by 2 ✓(e) <i>Deel deur 2</i>

$$K_c = \frac{1}{[\text{Cl}_2]^2} \quad \checkmark \text{ (f)}$$

$$= \frac{1}{(2)^2} \quad \checkmark \text{ (g)}$$

$$= 0,25 \quad \checkmark \text{ (h)}$$

No K_c expression/*Verkeerde K_c-uitdrukking:*
Max./Maks. $\frac{7}{8}$

Wrong K_c expression/*Verkeerde K_c-uitdrukking:*
Max./Maks. $\frac{5}{8}$

OPTION/OPSIE 2

$$n(\text{Ti})_{\text{reacted/reageer}} = \frac{m}{M} = \frac{336 - 288}{48} \checkmark = 1 \text{ mol}$$

$$n(\text{Cl}_2)_{\text{reacted/reageer}} = 2n(\text{Ti}) = 2(1) \checkmark = 2 \text{ mol}$$

$$n(\text{Cl}_2)_{\text{initial/aanvanklik}} = \frac{m}{M} = \frac{426}{71} \checkmark = 6 \text{ mol}$$

$$n(\text{Cl}_2)_{\text{equilibrium/ewewig}} = 6 - 2 \checkmark = 4 \text{ mol}$$

$$c = \frac{n}{V} = \frac{4}{2} \checkmark$$

$$= 2 \text{ mol} \cdot \text{dm}^{-3}$$

$$K_c = \frac{1}{[\text{Cl}_2]^2} \quad \checkmark$$

$$= \frac{1}{(2)^2} \quad \checkmark$$

$$= 0,25 \quad \checkmark$$

No K_c expression/*Verkeerde K_c-uitdrukking:*
Max./Maks. $\frac{7}{8}$

Wrong K_c expression/*Verkeerde K_c-uitdrukking:*
Max./Maks. $\frac{5}{8}$

(8)

6.2.2 Remains the same / *Bly dieselfde* ✓

(1)

[16]